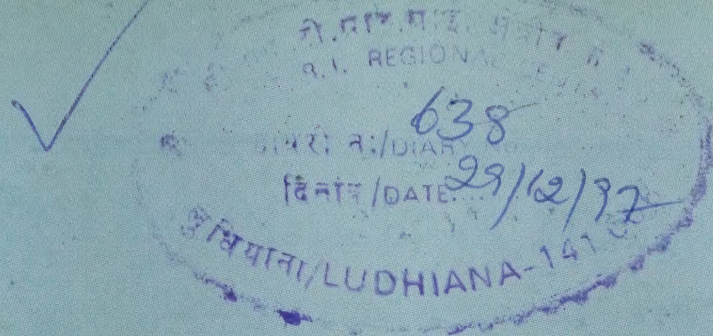




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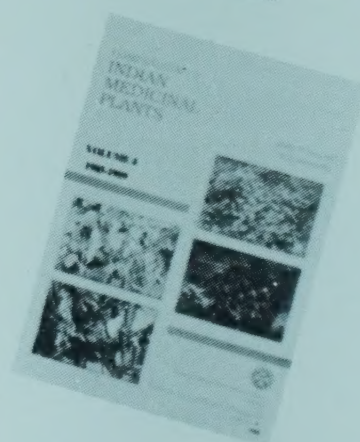
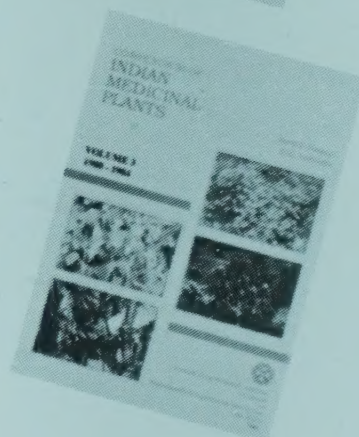
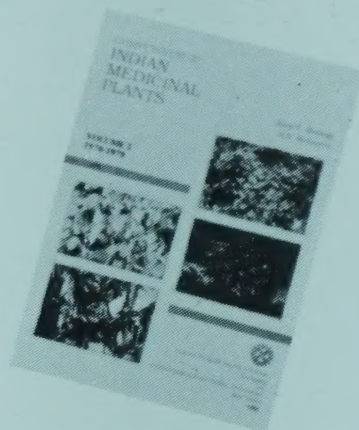
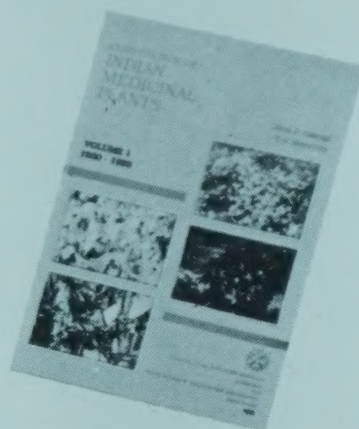
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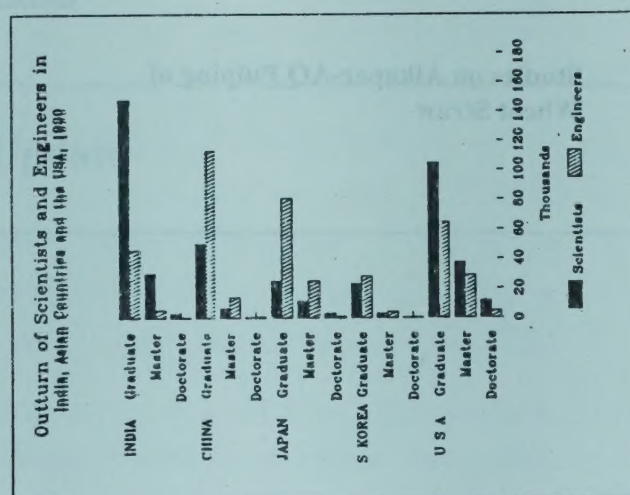
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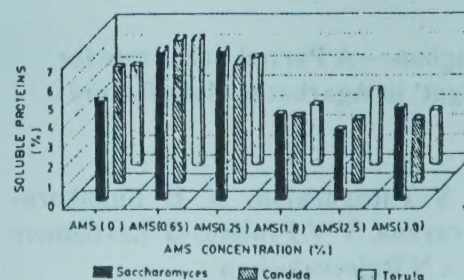
Comparing the outturn of S&T manpower in India with other Asian countries, in general, and with the US, in particular, for the period 1966 to 1989, China is found to be the top producer of graduate engineers followed by Japan, the US and India. However, India produced larger number of science graduates during this period.



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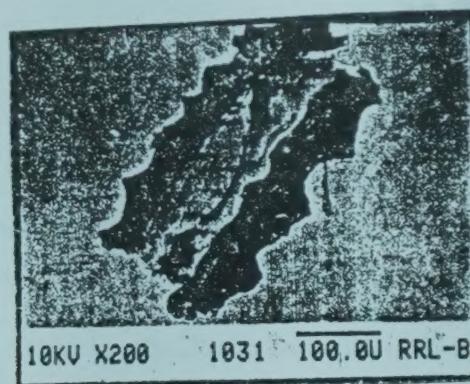


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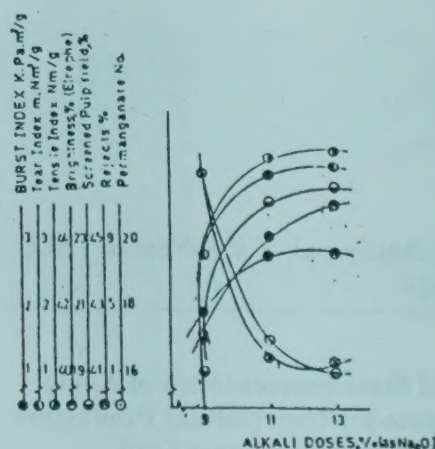
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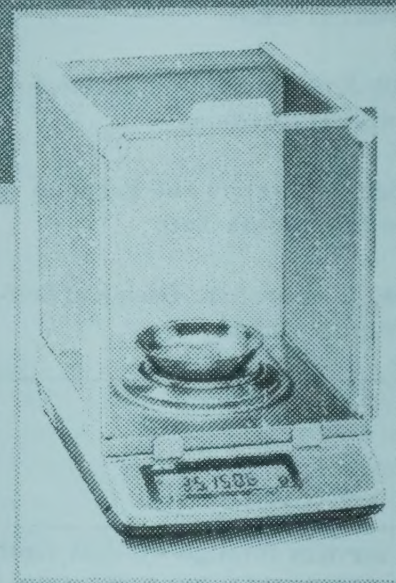
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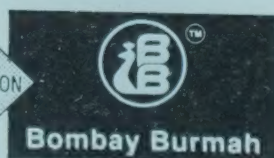
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Trends in Outturn of Scientific and Technical Manpower in India, Asia and the USA — A Comparative Analysis

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National Human Resource Development Directorate, CSIR Complex, Pusa, New Delhi 110 012, India

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National Human Resource Development Directorate (NHRDD) of the Council of Scientific and Industrial Research (CSIR) has been collecting data and compiling information on the annual outturn of trained manpower in all the fields of science and engineering from various universities and colleges, and the institutions having deemed-university status. A comparative analysis is made here of 'S & T Manpower in India' with other Asian countries in general, and with the USA, in particular, on the basis of outturn data for the period 1966 to 1989.

Introduction

National Human Resource Development Directorate of the Council of Scientific & Industrial Research (CSIR) has been collecting, compiling and disseminating information relating to S & T manpower in the country, since 1948. The outturn data for S & T manpower for the period 1950 to 1989 on Natural Sciences, Engineering and Technology, Medical Sciences, and Agricultural Sciences were published in 1993. What follows is a comparative analysis of the S & T manpower in the other Asian countries, in general, and the USA, in particular. The comparison is based on data contained in the publications of the National Science Foundation (NSF), USA and data available with NHRDD (erstwhile HRDG). Comparison beyond 1989-90 is not yet possible due to the lack of data for all the countries considered.

Asian Countries

With a new global economic order gaining currency, the life span of technologies is becoming shorter in general, this may show that the concept of one time education no longer holds good. In the developed countries, technical education has undergone noticeable changes and the developing countries like India, China, and South Korea have to contend with global competition in staking their goods and services in markets abroad. Many coun-

tries are emulating the example of Japan in developing their economic strength by increasing their technological capabilities. Further, as is known, the cultural heritage of India vis-a-vis China and other east Asian countries has similarities from time immemorial. Yet the progress made by each of them in Science — be it in education or research — has been significant. Some of them — Japan and Korea to be precise — have registered remarkable progress. It is to be noted that even before the onset of globalization of Economy, these countries were seen to have introduced deliberate measures, to enhance the participation of industries in Research & Development (R & D), and science education. It is therefore appropriate that our data pertaining to S & T manpower are compared with those of the Asian countries. The comparison with the USA is, of course, for obvious reasons.

The four Asian countries, i.e., China, India, Japan, and South Korea which represent 75% of the Asian and 40% of the world population produced more than half-a-million science and technology graduates in 1990. In the same year, the USA turned out 66% of the total produced altogether by these four countries. There are various factors which contribute to the overall economic growth of a country in general and industrial production, in particular. Factors which influence the economic strength of a country include

its control on population growth, its educational infrastructure with the right emphasis on science and technology, its total expenditure on R & D and also its market strategy backed by wide ranging quality products. Efforts have been made to compare these parameters within the four Asian countries viz. China, India, Japan, and South Korea. Population-wise, the decennial rates of growth of China, India, Japan, and South Korea from 1980 to 1990 were 1.55, 2.35, 0.57, and 1.23, respectively, whereas the decennial rates of growth of enrolment in higher education between 1980 and 1990 stood at 13.1, 6.1, 1.0, and 14.4, respectively and those of the total outturn of S & T graduates were 2.2, 2.5, 0.57, and 22.5, respectively. India had the highest growth rate of population between 1980 and 1990, whereas its rate of growth in enrolment in higher education during this period was less than half of that of China or

Korea. In spite of its size, the growth rate of outturn of S & T graduates of South Korea was eleven-times that of India. While India and China spent less than 1% of its GDP on R & D, South Korea and Japan spent 2 to 3% of its GDP on R & D, during this decade. In fact, South Korea increased its expenditure on R & D from 0.6% in 1980 to 1.9% of its GDP in 1990, whereas only a marginal increase of only 0.2% was observed in the case of India, during this period (Table 1).

It is an axiom that for enhanced industrial production of a country engineers and technologists play a vital role. Japan, now renowned for high quality products in the world, produced in 1990, about 81,000 first degree holders in engineering and technology and one-fourth of them acquired post-graduate and doctorate degrees. This certainly leads to all round value addition. On the other hand, India pro-

Table 1—Population, enrolment, outturn and expenditure of four Asian countries (including their Decennial growth rates between 1980 and 1990)

Country	Population in million		Decennial growth rate	Enrolment in higher education		Decennial growth rate	Total outturn of all S & T graduates		Decennial growth rate	R & D expenditure as % of GDP	
	1980	1990		1980	1990		1980	1990		1980	1990
0	1	2	3	4	5	6	7	8	9	10	11
China	981.2	1133.7	1.55	11,44,000	26,51,396	13.1	NA	187,953	2.2	NA	0.7
India	687.3	849.5	2.35	27,52,437	44,25,247	6.1	166,103	213,217	2.5	0.6	0.8
Japan	116.8	123.5	0.57	24,12,117	26,54,379	1.0	255,867	26,,985	0.57	2.0	2.9
South Korea	38.1	42.8	1.23	6,47,505	15,83,076	14.4	21,022	61,477	22.5	0.6	1.9

Table 2 — Outturn of science and engineering graduates in 1990

Country	Natural sciences			Engineering and technology		
	Graduates	Master's degree	Doctorates	Graduates	Master's degree	Doctorates
0	1	2	3	4	5	6
India	1,48,000	30,000	3,050	42,000	5,340	400
U S A	1,05,021	37,621	11,368	64,705	28,887	4,892
China	50,000	6,760	772	1,13,000	14,027	1,054
Japan	25,000	11,639	937	81,000	24,910	948
S Korea	23,000	3,056	399	28,071	4,014	439

duced only about 42,000 engineering and technology graduates, i.e. just half of that of Japan in the same year; only one-ninth of them acquired post-graduate degrees. As for China, it produced 1,13,000 first degree engineers and technologists (Table 2).

Outturn of Scientists and Engineers

On a comparison of the outturn of S & T personnel of the countries of Asian region and the USA, it is observed that in 1990, India accounted for more than 50 % of the bachelor's degrees awarded in natural sciences in Asia; this was three- times that of China and six-times that of Japan and South Korea. India is also the world's foremost producer of first degrees and Ph D degrees in natural sciences. But in the case of engineering and technology fields China and Japan are and will remain the main producers of holders of first degrees in engineering subjects. For the Asian region, China in 1990 had the highest number (1,13,000) of engineering graduates; Japan follows with 81,000 graduates. India, having produced around 42,000 graduates, 5340 master's, and 400 doctorate degree holders in engineering, is far behind the other Asian countries and the USA. China's outturn was more than double the number at all levels. South Korea produced a less number of engi-

neering graduates but it has awarded more doctorates in engineering and technology fields (Table 2).

Outturn of Post-graduate Scientists: India vs the USA

The annual outturn of the Master's degree holders in India in 1966 was half that of the USA but in the seventies and eighties the growth rate in India was much higher. This enabled India to produce, by 1989, nearly the equal number of Master's degree holders in science subjects as compared to the USA. In the case of doctorates in science subjects India had made good progress. The ratio of outturn of doctorate degrees in the sixties for India vs the USA was 1:9 which reduced to around 1:4 in 1989. The ratio of the outturn of Doctorates vs Master's degrees in science subjects was 1:9 in India, whereas it was 2:5 in the USA. Thus, in the USA, 40 per cent of the Master's degree holders go on to secure doctorate level qualifications, whereas only 11 % do so in India (Table 3).

Subject-wise Analysis

If we analyse subject-wise growth of outturn, we observe that in the case of Chemistry at Master's level we had in 1966-67 almost an equal number as that of the USA. But during the last two decades India

Table 3 — Outturn of master's and doctorate degree holders in natural sciences from 1960 to 1989

Year	Master's degree		Doctorates	
	India	USA	India	USA
0	1	2	3	4
1966	8269	15757	746	7102
1967	9216	19286	897	7985
1968	10685	20588	1005	8944
1969	13116	22424	1070	9852
1970	13214	23010	1163	10867
1971	14964	24247	1170	11522
1972	16213	25475	1284	11411
1973	18272	25991	1335	11407
1974	18868	26900	1455	11044
1975	18469	26502	1592	11096
1976	18212	26749	1670	10961
1977	16798	27629	2015	10848
1978	18326	27418	2045	10762
1979	19393	26816	2070	11032
1980	19812	26463	2416	11012
1981	21339	26425	2670	11332
1982	22812	27225	2689	11343
1983	22781	27928	2718	11514
1984	25234	28297	2756	11589
1985	27081	29617	2793	11440
1986	28489	30803	2912	11738
1987	30141	30871	2591	12035
1988	29042	31237	3066	12483
1989	29997	31237	3011	12775
Total	4,70,743	6,28,895	47,139	2,62,094

has made a significant jump in its outturn of master's degree holders in chemistry, whereas in the USA it had almost remained stationary (Table 4). At the doctorate level also, India in terms of strength in chemistry has shown more or less the same growth rate as that of the USA. In the year 1966-67, the USA vs. India ratio of outturn of Doctorates in Chemistry was 2:11; it narrowed to 2:5 in 1989.

In the case of Physics and allied subjects in 1966, India's outturn was about 40% less than that of the USA; but in 1989 there was a big swing in India's favour as our outturn in these subjects became more than double as compared to that of the USA. In case of Doctorates in Physics the trend was similar to that of Chemistry (Table 5).

Computer Science is the only field in which the USA has had a steady and continuous increase in outturn. At the Master's level, India began with eleven persons in 1980, whereas the same year in the USA 3647 persons took the Master's degree in that subject. In 1989, the outturn in India went up to 299 at Master's level compared to 9399 in the USA. The gap in the outturn at Master's level in computer science however reduced but not to the extent as in the case of other science subjects. At the Doctorate level there were only six persons awarded the degree in India compared to 612 in the USA (Tables 6 to 10 for annual outturn in the fields of Earth Sciences, Mathematics and Statistics, Computer Science, Psychology and Biological Sciences).

Concluding Remarks

Four Asian countries produced more than half-a-million first degree holders in natural sciences and engineering in 1990. This was two-and-a-half times more than the number of first degrees awarded by the USA. But there are significant variations in the number of science and engineering degrees awarded in the Asian Countries and the USA. In China, 37 per cent of all first degrees were in the engineering fields while in India it was just four per cent. On the other hand, India awarded 20 per cent first degrees in natural sciences against 14.6 % in China; 74% of first degrees awarded in India were in arts and humanities, commerce, education, etc.; Japan awarded 20 per cent of its first degrees in engineering and technology. At post-graduate and higher levels, the USA had a higher outturn compared to any of the Asian coun-

tries, may be because a large number of students from Asian countries proceeded there for higher studies.

According to NSF, the flow of Science and Technology (S & T) immigrants to the USA reached an all time high of 23,000 in 1992. Most of these immigrants were from India, China, Taiwan and Korea. Over four lakh students, i.e. three per cent of the total USA enrolment, attended the US institutions of higher education and more than half of these students (55%) migrated from Asia. The United States produced and maintained the largest science and engineering manpower in the industrialized world and continued to lead it by the maximum expenditure on R&D. The total USA expenditure on R&D reached an estimated \$161 billion in 1993 (2.6 per cent of GDP). India spent less than one per cent of its GDP on R&D.

S & T manpower is the key to the future of any nation. Financing of higher education along with the restructuring of our economy and making various sectors competitive within the country are major issues to be tackled carefully. We need to generate funds from the beneficiaries and industries for sponsoring higher education and research. It is high time that our well-established industries should come forward to invest in higher studies to ensure high quality manpower for the pursuit of their programmes. The bridge between universities and industries has not only to be built but buttressed to enable us to become a technologically advanced nation.

Analysis of data herein establishes beyond doubt one fact: the countries that have attained or are on the road to achieving technological strength/superiority have been (and are) producing more engineering/technological manpower, as compared to those that lag behind. India is far behind the USA in terms of production of highly qualified engineers/technologists. The document CSIR 2001 — Vision and Strategy declares the CSIR Mission statement thus — "To provide scientific industrial research and development that maximises the economic, environmental and societal benefits for the people of India". This clearly underlines the need for engineering/technological inputs of a kind that is not at present manifest in our R & D institutions. Industrial Research leading to innovations (products and processes) in the shop floor cannot reach competitive heights unless backed by strong engineering/technological skills. Hence,

Table 4 — Annual outturn of doctorates and master's degree holders in Chemistry

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966	1629	1839	284	1594
1967	1865	1831	315	1773
1968	2322	2014	343	1803
1969	2681	2070	355	1967
1970	2873	2146	411	2238
1971	3158	2284	371	2211
1972	3711	2259	427	2019
1973	4221	2230	410	1855
1974	4386	2138	439	1797
1975	4294	2006	534	1776
1976	4118	1796	548	1624
1977	4060	1775	690	1571
1978	4451	1892	651	1544
1979	4440	1765	706	1566
1980	4553	1733	774	1538
1981	4899	1667	880	1612
1982	4953	1758	796	1680
1983	4931	1632	848	1759
1984	5202	1677	789	1765
1985	5395	1734	872	1836
1986	5664	1764	898	1903
1987	5537	1750	770	1975
1988	5650	1702	876	2016
1989	5638	1800	834	1971
Total	1,00,631	45,262	14,821	43,393

Table 5 — Annual outturn of doctorates and master's degree holders in Physics

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966	1254	2008	127	1061
1967	1374	2180	155	1312
1968	1706	2168	174	1436
1969	2026	2366	202	1461
1970	1993	2139	199	1655
1971	2156	2302	215	1738
1972	2411	2202	223	1634
1973	2784	1847	242	1589
1974	3005	1751	214	1339
1975	2594	1690	275	1300
1976	2579	1540	279	1237
1977	2091	1400	287	1150
1978	2302	1389	289	1067
1979	2582	1435	320	1108
1980	2558	1271	342	983
1981	2768	1352	328	1015
1982	2883	1364	369	1014
1983	2963	1438	382	1043
1984	3279	1602	389	1080
1985	3605	1614	342	1080
1986	3730	1584	440	1187
1987	4077	1614	341	1237
1988	4004	1769	389	1303
1989	3862	1839	420	1278
Total	64,586	41,864	6,943	30,307

Table 6 — Annual outturn of doctorates and master's degree holders in Earth sciences(Geophysics/Geology)

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966	410	759	26	404
1967	490	971	32	415
1968	390	1008	37	433
1969	449	1124	34	496
1970	392	1124	47	498
1971	427	1227	51	536
1972	422	1408	67	598
1973	566	1470	48	624
1974	556	1679	62	615
1975	650	1503	51	625
1976	656	1581	57	641
1977	695	1659	52	689
1978	767	1832	48	621
1979	925	1777	61	642
1980	846	1793	85	628
1981	849	1876	78	583
1982	1054	2012	78	657
1983	994	1959	99	624
1984	1081	1982	98	608
1985	1135	2160	121	599
1986	1187	2234	120	559
1987	1140	2051	91	602
1988	1087	1920	116	695
1989	1071	1819	104	720
Total	18,239	38,928	1,663	14,112

Table 7 — Annual outturn of doctorates and master's degree holders in Mathematics including Statistics and O R

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966	1843	4772	66	769
1967	1982	5284	123	830
1968	2355	5533	130	971
1969	3354	5723	128	1070
1970	3087	5648	106	1225
1971	3641	5201	126	1238
1972	3780	5209	138	1281
1973	3980	5033	170	1232
1974	3995	4840	171	1211
1975	3544	4338	193	1147
1976	3453	3863	198	1003
1977	2942	3698	231	933
1978	3029	3383	222	838
1979	3356	3046	218	769
1980	3649	2868	267	744
1981	4061	2569	259	728
1982	4345	2731	253	720
1983	4580	2839	229	701
1984	5092	2749	285	698
1985	5812	2888	250	688
1986	6211	3171	241	729
1987	7276	3327	236	740
1988	7130	3434	265	749
1989	7948	3431	261	861
Total	1,00,445	95,578	4,766	21,875

Table 8 — Annual outturn of doctorates and master's degree holders in Computer sciences

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966		238		19
1967		449		38
1968		548		36
1969		1012		64
1970		1459		107
1971		1588		128
1972		1977		167
1973		2113		196
1974		2276		198
1975		2299		213
1976		2603	1	244
1977		2798	1	216
1978		3038	1	196
1979		3055	1	210
1980	11	3647	5	218
1981	11	4218	3	232
1982	15	4935	0	220
1983	20	5321	7	286
1984	65	6190	0	295
1985	63	7101	6	310
1986	69	8070	0	399
1987	181	8481	0	450
1988	152	9166	8	515
1989	299	9399	6	612
Total	886	91,981	39	5,569

Table 9 — Annual outturn of doctorates and master's degree holders in Psychology

	Master's degree		Doctorates	
	Year	India	USA	India
1966	45	2530	3	1139
1967	35	3138	3	1295
1968	50	3482	4	1464
1969	44	4013	4	1766
1970	56	4120	1	1890
1971	42	4438	1	2145
1972	45	5293	3	2279
1973	49	5882		2458
1974	55	6616	1	2598
1975	49	7104	2	2751
1976	57	7859	1	2883
1977	39	8320	2	2990
1978	62	8794	2	3055
1979	57	8031	1	3091
1980	38	7861	1	3098
1981	86	8039	3	3358
1982	38	7849	3	3359
1983	56	8439	2	3347
1984	521	8073	12	3257
1985	512	8481	10	3117
1986	501	8363	8	3124
1987	589	8165	11	3169
1988	591	7925	10	3064
1989	536	8652	17	3209
Total	4,153	1,61,467	105	65,906

Table 10 — Annual outturn of doctorate and master degree holders in Biological sciences
(Includes Botany, Marine, Microbiology, Zoology, Oceanography Environment, Biotechnology/Biophysics, Fisheries, and Other biological Sciences)

Year	Master's degree		Doctorates	
	India	USA	India	USA
1966	1638	4235	206	2135
1967	1858	5003	237	2360
1968	2178	5517	296	2827
1969	2741	5765	314	3092
1970	2740	5835	350	3361
1971	3486	6280	352	3654
1972	3845	6634	350	3600
1973	4562	6689	388	3648
1974	5036	7081	490	3484
1975	5354	6931	493	3497
1976	5449	6939	540	3573
1977	4938	7468	670	3484
1978	5558	7227	777	3516
1979	5938	7220	695	3646
1980	5861	6854	860	3803
1981	6279	6299	1030	3804
1982	6812	6184	1064	3893
1983	6903	6041	1059	3741
1984	7079	5717	1082	3880
1985	7421	5345	1100	3792
1986	7580	5289	1041	3807
1987	7975	5260	988	3836
1988	7528	5062	1236	4108
1989	7673	5160	1187	4106
Total	1,26,432	1,46,035	16,805	84,647

there is a need to produce the right kind and sufficient number of trained engineers/technologists in the near future.

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Solid State Fermentation of Apple Pomace for Concomitant Production of Ethanol and Animal Feed

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Effect of some factors on solid state fermentation (SSF) of apple pomace using three different yeasts and natural fermentation were studied. Natural fermentation of apple pomace was inferior to the yeast inoculated fermentation for ethanol and crude and soluble proteins production. The production of ethanol in natural fermentation was almost half than that of *Saccharomyces cerevisiae* fermented pomace. The optimum time for ethanol production in SSF was 96h. *Saccharomyces cerevisiae* gave highest ethanol yields. Ethanol production by *Candida* and *Torula* was comparable. Combination of ammonium sulphate and zinc sulphate proved detrimental to ethanol and crude proteins and soluble proteins production both by natural microfloral and inoculated yeasts fermentation. The natural microflora also responded better to ammonium sulphate than the addition of ammonium sulphate in combination with zinc sulphate.

Introduction

Apple pomace though a waste from apple juice processing, is a good source of sugar, acid and minerals besides high fibre contents. Being highly biodegradable, its disposal into the environment causes pollution problems besides a loss of precious resource². Since it is a poor source of proteins, it is a poor animal feed supplement³. Enhancement of protein content of apple pomace can make it suitable for animal feed. Efforts have been made to utilize the apple pomace fermentatively for production of ethanol, citric acid and several other products³. Concomitant production of ethanol and animal feed from apple pomace by solid state fermentation has recently been reported (Joshi and Sandhu, 1994) where alongwith ethanol production, the crude protein enrichment of the fermented apple pomace had taken place. Addition of sulphur dioxide at the rate of 150 ppm of SO₂ as KMS has been found to be a practical alternative of steam sterilization⁴.

Natural microflora of any substrate due to better adaptability and substrate specificity can have edge over inoculated fermentation. Hang and Jarosz have reported occurrence of natural fermentation besides inoculated fermentation by strains of *Saccharomyces cerevisiae*^{5,6}. It is however, not known if manipulating the conditions of fermentation also influences the natural microflora especially, the addition of nitrogen source or such growth enhancer and if so to what extent. Similarly, for ethanol production, the maximum time interval has not been determined yet. Optimization of concentration of nitrogen source as such or in combination with source of trace elements such as Zn also needs to be investigated for effective solid state fermentation of apple pomace. The results obtained on the effect of addition of increasing concentration of nitrogen source, type of inoculum, time of fermentation etc. on ethanol and crude and soluble protein production from apple pomace are presented in this communication.

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Materials and Methods

Apple Pomace

Apple pomace was obtained as a by-product of the apple juice extraction or was collected directly from the outlet of fruit processing plant at Parwanoo (HP). It was transported within 2-3 h, dried to a constant weight in a mechanical dryer at $60\pm1^\circ\text{C}$ for about 8h for the subsequent studies. However, fresh apple pomace was used directly in the experiment where effect of natural source of fermentation of apple pomace was to be determined.

Microorganisms

Saccharomyces cerevisiae (UCD 595) were procured from the Department of Enology and Viticulture, California, Davis (USA) while that of *Candida* and *Torula* were obtained from National Chemical Laboratory, Pune (India). The yeast cultures were maintained on malt-yeast extract slants and before use, were grown on malt-yeast extract broth. An active culture was prepared and used for fermentation. The incubation was done at $28\pm1^\circ\text{C}$ for 24-48 hours.

Solid State Fermentation

Dried apple pomace was used as solid substrate. Ratio of apple pomace to water was kept at 1:4 which was sterilized at 121°C for 15 min. All fermentations were carried out in the same manner except as detailed under the specific experiment. Incubation was done at $25\pm1^\circ\text{C}$ under stationary conditions and were initiated by the addition of 5% active culture of the respective yeasts. Ammonium sulphate as a nitrogen source was added at the rate of 0.1% to the reconstituted apple pomace. All the fermentations were monitored for ethanol production after every 24 h. After fermentation the left-over material was dried at $60\pm1^\circ\text{C}$ in a mechanical dehydrator. The dried fermented apple pomace was packed in 200 gauge polyethylene bags and were sealed, using a mechanical sealer.

Effect of Zinc Sulphate and Ammonium Sulphate

Dried apple pomace was reconstituted as detailed earlier. Four sets of fermentation were laid out. Each set contained ammonium sulphate 0.4% the second ammonium sulphate 0.4% + ZnSO_4

(20mg/kg) and the third none of the above. All the sets except for natural microfloral fermentation were sterilized. Three sets were inoculated with *S. cerevisiae*. Inoculations, fermentations and drying were carried out as above.

Effect of Ammonium Sulphate

Different levels of ammonium sulphate as the nitrogen source viz. 0.65, 1.25, 1.80, 2.50 and 3.0% were used. Three yeasts viz. *S. cerevisiae*, *Candida utilis* and *Torula utilis* were used. Other details remained the same as described earlier.

Analyses

Ethanol contents in the fermented apple pomace were determined by colorimetric procedure of Caputi⁷. The crude and soluble proteins in the dried samples were analysed as per the standard procedures^{8,9}. Before fermentation, apple pomace was also analysed for total sugar, pH and original moisture contents⁹.

Results and Discussion

Rate of Ethanol Production

Results on ethanol produced at different intervals of time during SSF of apple pomace (Fig. 1) showed that with the increase in fermentation time increase in ethanol yield took place up to 96 h. No further increase in the ethanol content after this period was observed in the fermented apple pomace by any of the yeasts. The data showed that increase in ethanol took place even in the samples undergoing natural fermentation but their rates were too slow and the ethanol produced was virtually half as compared to that produced by *S. cerevisiae*. However, the difference in the natural source of fermentation and the inoculated yeasts started its manifestation within 24 hours (Fig. 1). In case of natural fermentation which showed slowest ethanol production rates, like the yeast inoculated fermentation, the curve started flattening at 96 h. This can be attributed to initial competition between the ethanol producing micro-organism and non-ethanol producing micro-organisms to get established, after which ethanol producers due to high substrate specificity and the conditions of fermentation, might have got established and completed the fermentation process. It is a normal trend in the spontaneous fermentation. Our

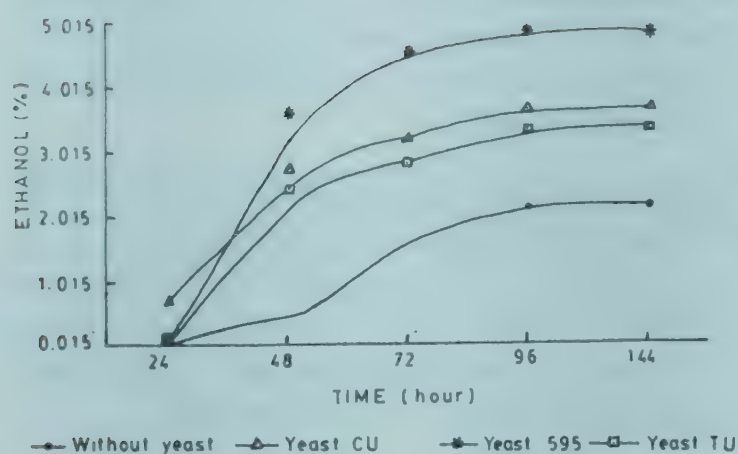


Fig. 1 — Comparison of rate of fermentation of apple pomace fermented by different yeast and natural fermentation (Initial Sugar Conc. = 10%).

results are in further confirmation to those obtained by Jarosz³ on solid state fermentation of apple pomace by *S. cerevisiae* strains. But are contrary to the findings of Hang who reported that natural fermentation of apple pomace was not possible. As per the previous trend *S. cerevisiae* showed maximum ethanol production followed by *Candida* and *Torula*. Though, the difference between *Candida* and *Torula* was only marginal but these yeasts produced more ethanol than the natural fermentation.

Candida which has produced ethanol is generally taken as strictly aerobic mainly concerned with biomass production only. However, these results are in confirmation to those obtained by Varna¹⁰.

Effect of Ammonium Sulphate (AMS) and Zinc Sulphate

Compared to the control, increase in ethanol yield took place with the addition of both AMS and AMS + ZnSO₄ (Fig 2). The combined effect of AMS and ZnSO₄, however, was detrimental to the ethanol production but AMS alone gave better ethanol yield. The effect was more visible with *S. cerevisiae* than *Candida* and *Torula* or the natural source of inoculum. However, the addition of Zn, Fe, MnSO₄ and CoCl₂ has been found to stimulate though to the variable extent, the ethanol production in both the strains of *Saccharomyces* investigated earlier.

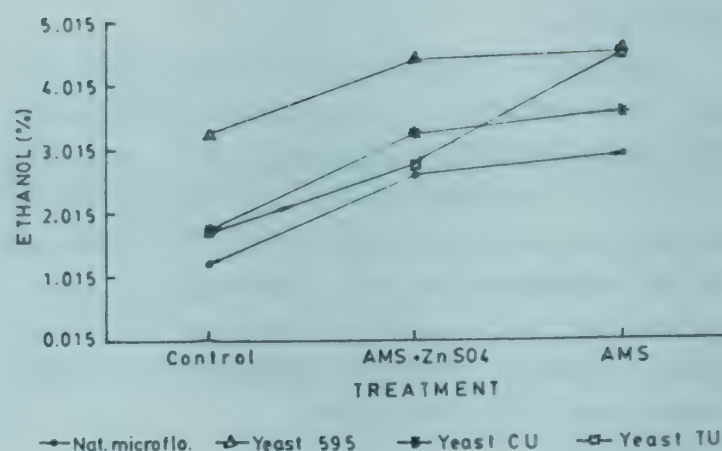


Fig. 2 — Effect of addition of N. source/trace element on ethanol production by different yeasts and natural microflora. (AMS = Ammonium sulphate)

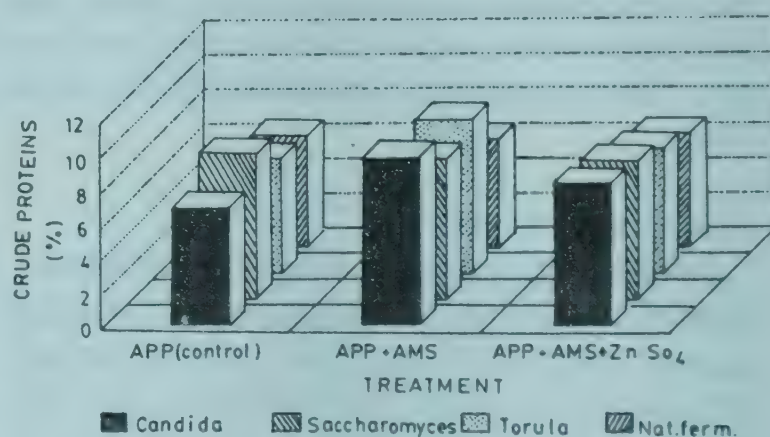


Fig. 3 — Comparison of proteins of apple pomace fermented by different yeasts and natural fermentation as effected by the treatments.

Figure 3 compares the crude protein content of the apple pomace fermented by different yeasts and natural fermentation as affected by AMS and its combination with ZnSO₄. Compared to the control, AMS alone increased the crude protein but its combination with ZnSO₄ had antagonistic effect, though better than control. Although the increase in the crude protein took place even in naturally fermented apple pomace, all the yeasts tried were better.

Figure 4 compares the soluble protein content of apple pomace by different yeasts and natural fermentation as effected by AMS and its combination with

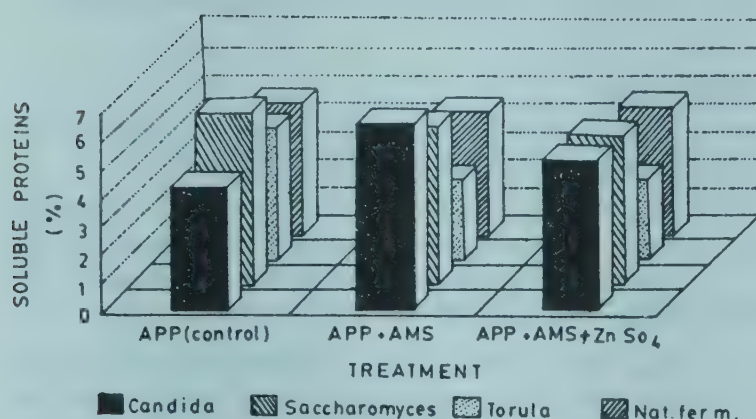


Fig. 4 — Comparison of soluble proteins of apple pomace fermented by different yeasts and natural fermentation as effected by the treatments.

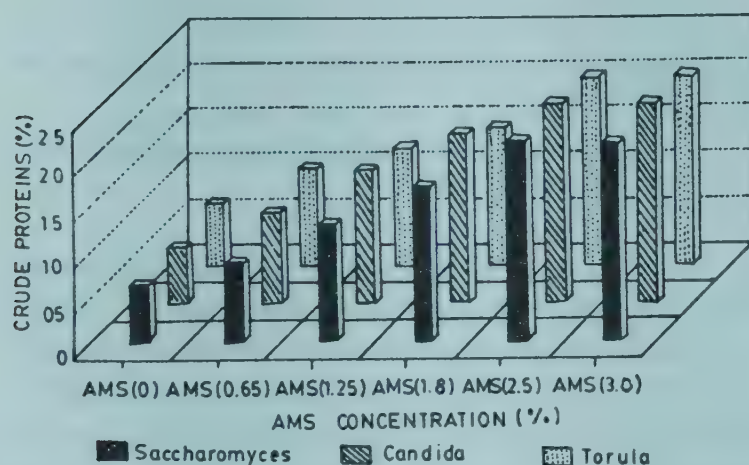


Fig. 6 — Effect of different concentrations of ammonium sulphate (AMS) on crude proteins of apple pomace fermented by different yeasts.

ZnSO₄. Compared to the control, AMS addition gave higher soluble proteins than its combination with ZnSO₄ probably due to the antagonistic effect. Although, all the yeasts were better yet increase in the crude proteins took place even in the naturally fermented apple pomace also.

Effect of Concentration of Ammonium Sulphate

Figure 5 depicts the effect of addition of increasing concentration of ammonium sulphate on the ethanol yield by the three yeasts. The increase in the AMS concentration enhanced ethanol content upto a concentration of 1.8% after which it decreased substantially. All the yeasts behaved similarly. It is also

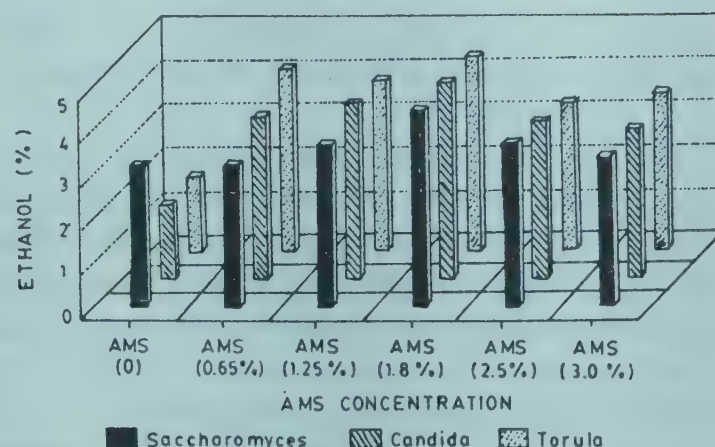


Fig. 5 — Effect of addition of different concentration of ammonium sulphate (AMS) on ethanol production in apple pomace fermentation.

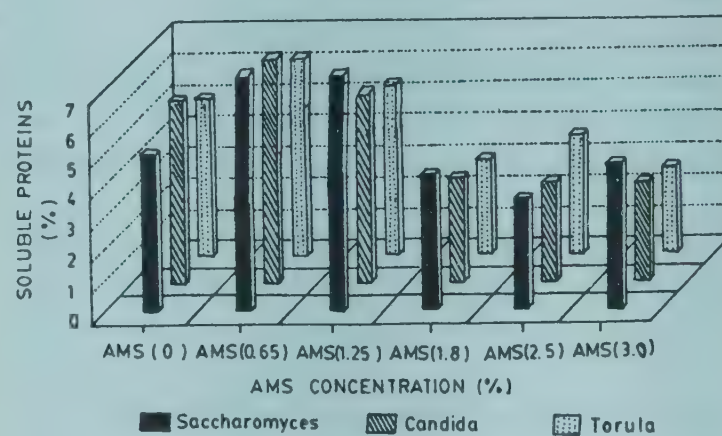


Fig. 7 — Effect of different concentration of ammonium sulphate (AMS) on soluble proteins of apple pomace.

apparent that the optimum concentration of AMS varied between 1.25 to 1.80 per cent. Need of optimization of AMS concentration for increasing the fermentation efficiency of ethanol production has been stressed earlier. The decline obtained at higher AMS concentration might be the result of toxic effect of higher concentration of ammonium ions on the growth of these yeasts.

Figure 6 shows that with increase in concentration of AMS, a continuous increase in the crude proteins content of apple pomace took place upto 2.5 per cent after which it got stabilized. The response of different yeasts to the increasing concentrations of AMS was similar. The increase in AMS concentration

enhanced the crude proteins contents considerably. However, an increase in concentration of AMS brought a decrease in soluble protein contents of apple pomace (Fig 7).

The amount of crude proteins in the fermented apple pomace has been influenced by the addition of nitrogen source; its type and concentration as well as the source of fermentation used in this fermentation. The increase in the crude proteins of the medium due to addition of nitrogen sources is understandable due to availability of more nitrogen for growth of micro-organisms and apparently due to the enrichment of medium with proteins. Solid state fermentation has been found to enrich the waste with proteins and it produced a good source of animal feed¹¹.

The increase in protein content by fermentation is definitely a novel approach for nutritional improvement of the wastes from the processing industry which are quite high in biochemical oxygen demand¹². Solid state fermentation of apple pomace with the addition of ammonium sulphate and with controlled fermentation with *S.cerevisiae* rather than

spontaneous fermentation holds promise the production of ethanol and protein enriched animal feed.

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A Study of Alumina Particulates using Cellulosic Substrates

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The salient features for production of ceramic fibres from various plant materials using substrate mechanism of digestion with salt solution, followed by coking (350°C) and pyrolysis (1000°C) are presented. Micrographs of alumina particulates have been obtained using saw dust as well as cellulose powder. The diameter of the alumina particulates formed from saw dust are in the range 0.25-0.37 mm while the diameter of those based on cellulose is 0.34 mm. Production of zeolite type silicate and aluminosilicate from rice husk is also reported.

Introduction

One of the major bottlenecks in widespread utilization of ceramic fibres and particulates is the cost. While high purity and perfection have been achieved by well known techniques¹⁻³, there has been no effort to bring down their cost. The substrate mechanism, proposed initially for the production of SiC whiskers⁴⁻⁶ and extended recently to alumina fibres⁷⁻¹⁰, can make a breakthrough in reducing the cost. The cost of production by this technique is expected to be significantly low because the process is simple and requires lower temperature. Moreover, many ceramic fibres and particulates can be produced in the same industry, simply by varying the substrates and salt solution. In view of the limitations in marketing of these materials, production of a number of ceramic fibres and particulates in the same industry could be highly attractive commercially.

The plant products are essentially composed of cellulose along with lignin, carbohydrates, pectin, wax, oils and a number of metallic elements. Heat treatment of such cellulosic products at 500-600°C in air or oxygen causes oxidation of the carbonaceous part and leaves behind residues containing mainly

metallic oxides. On the other hand, in the absence of oxygen, carbon can be retained up to a quite high temperature, the outcoming gases (H₂, CO, CH₄, etc.) being reducing in nature.

The plant products can be fibrous or non-fibrous with various shapes, dimensions and physical properties. Natural fibres such as sisal have well-defined capillary structures while rice husk possesses popcorn type⁵ fibrous network with a rigid body. Wood dust and cellulose powder are non-fibrous, found usually in powder form. Because of their highly porous structure, all cellulosic materials are amenable to the phenomenon of adsorption followed by capillary action in the natural fibres⁶.

Rice husk is endowed with 16-20% silica, out of which 6% is firmly bonded with carbon forming Si-C type compounds⁴ that act as substrate for the initiation and growth of SiC whiskers. The remaining silica is in free form. This reacts with NaOH and forms Na-silicate. On controlled causticization, the silica content in rice husk can be varied which are digested with Al-salt solution and then pyrolysed to obtain aluminosilicates of different compositions¹¹.

The production of alumina fibres using jute fibres was reported recently by the authors^{6,7}. Fibres obtained from the industrially processed sisal fibre have

*For Correspondence

perfect structures. The substrate mechanism can be applied for the production of multitude of inorganic fibres¹² and particulates of desired dimensions and shapes, as the present study shows.

Method & Materials

Alumina particulates were produced from wood dust and cellulose powder by first digesting with AlCl_3 solution and then pyrolysing the coked products at 1000°C . The textural properties and crystalline form of the particulates have been found to be of unusual types and are replica of the initial substrates. β -alumina were obtained from rice husk and Na-aluminate liquor.

Rice husk, jute and saw dust were of local origin (Koraput, Orissa) and were processed manually. The cellulose powder was of laboratory grade (BDH, England). Rice husk was washed repeatedly with

water (to remove clay and rice straw, etc.) and finally with dilute HCl . It was dried and sieved to remove the broken pieces of rice husk. The saw dust was also washed similarly with water.

The Na-aluminate liquor used was the green liquor of the alumina refinery plant. Heat treatment experiments were conducted under closed condition so that the reducing gases evolved from the system could be used for heating. Stainless steel containers were used for coking at 350°C - 400°C while the pyrolysis was carried out at 1000°C in the specially fabricated alumina reactors¹⁰.

Chemical analysis of the jute, sisal, coir, rice husk, saw dust and cellulose used in the study is shown in Table 1. In order to have a comparison with other plant fibres from which ceramic fibres have been produced, results of chemical analysis of jute, sisal and coconut coir are also given. All the materials are

Table 1 — Chemical analysis of raw materials

Constituents (wt. %)	Raw Materials					
	Jute	Sisal	Coir	Rice husk	Saw dust	Cellulose
Cellulose	84.29	89.67	73.71		82.16	99.95
Lignin	13.71	6.73	24.34	73.7	15.26	-
Wax	0.43	0.74	0.56	-	0.39	-
SiO_2	1.09	1.076	1.36	21.87	1.49	-
Fe_2O_3	0.51	0.266	0.24	1.34	0.59	-
Na_2O	0.075	0.112	0.121	0.66	0.09	-
K_2O	0.063	0.162	0.157	0.18	0.06	-
CaO	0.088	0.481	0.267	0.86	0.075	-
MgO	0.047	0.104	0.078	0.22	0.056	-
Al_2O_3	0.013	0.024	0.019	1.06	0.02	-
ZnO	0.058	0.024	0.021	-	0.046	-
P_2O_5	0.156	0.132	0.146	-	0.151	-
MnO	0.001	0.0015	0.001	0.06	-	-
CuO	0.002	0.0010	0.001	-	-	-
V_2O_5	0.001	0.0010	0.001	-	-	-
Cl^-	Traces	Traces	Traces	-	-	-
$\text{SO}_4^{=}$	-	0.0014	0.0016	-	-	-

— indicates not determined

cellulosic containing more than 70% cellulose. Rice husk is dominated by the inorganic oxides, specially SiO_2 , amounting to about 22%, unlike other raw materials.

Results and Discussion

The fibres produced appear to be replica of the plant fibre substances. As the plant fibres were invariably accompanied by short fibres, fibre debris, parenchyma cells, vessels, etc., short ceramic fibres and structures with particulate nature were also formed. In the products obtained previously from the coconut coir⁷, a higher number of such particulates was observed because of the high pith content (pith is not in fibrous form).

Optical micrograph (Fig.1) of alumina particulates produced from wood dust shows particulates of fairly round shape. The wood dust had been digested with AlCl_3 solution and then the coked product was pyrolysed at 1000°C . On examining the peripheral region of this product, hair type structure is observed, which is similar to the initial microscopic view of the saw dust. The AlCl_3 salt solution that diffuses into the capillaries or voids existing in the saw dust particles, decomposes finally to Al_2O_3 at 1000°C . Alumina formed by this process is apparently of low density.

When cellulose powder was taken as substrate and pyrolysed at 1000°C after digesting with AlCl_3 solution, hexagonal shaped alumina particulate (Fig. 2) was formed. Such structures can be assigned as

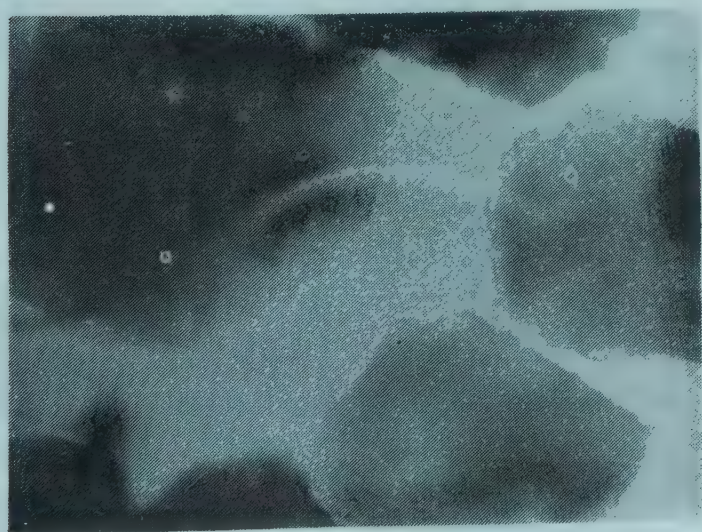


Fig. 1 — Optical micrograph of alumina particulates obtained using wood dust

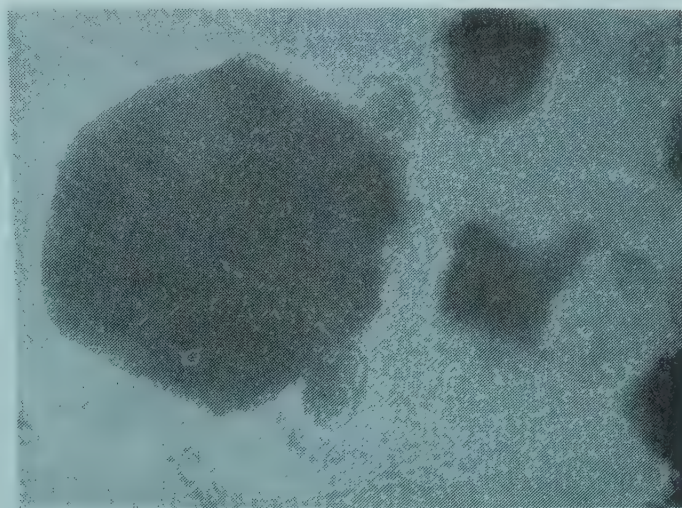


Fig. 2 — Optical micrograph of alumina particulates obtained using cellulose powder

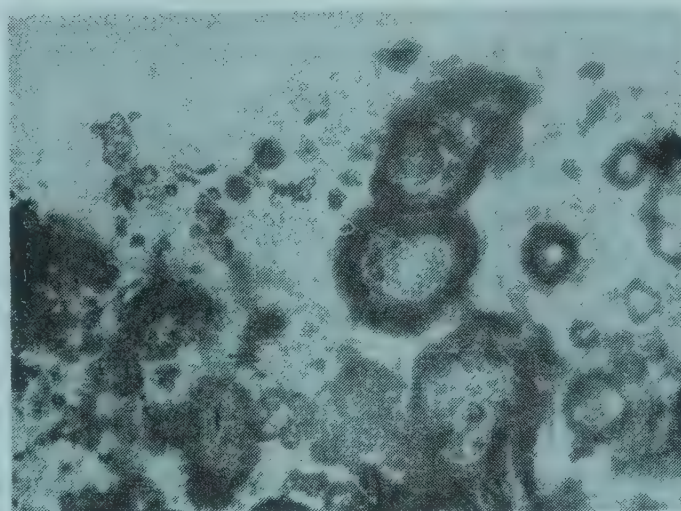


Fig. 3 — Optical micrograph of β -alumina obtained using rice husk

whiskers⁶ having potentiality to be used in Al-met composites.

Crystals appear closed packed in this case, compared to those in Fig. 1. These products are obtained at 1000°C only and if the temperature is increased to 1400°C - 1600°C , as in previous cases, it may be possible to obtain products of higher density.

The micrograph of products obtained on treatment of rice husk with the Na-aluminate liquor and then pyrolysing at 1000°C appear as shown in Fig. 3. It has been identified as β -alumina on the basis of XRD and chemical analyses. Though its chemical structure was similar to zeolite, properties such as high surface area and the corresponding adsorption of gases or moisture were lacking. In fact, the product appears to have two phases in the micrograph (Fig. 3), the



Fig.4 — Optical micrograph of aluminosilicate obtained using rice husk

centre portion constituting white glassy patches surrounded by black rings. More studies need to be carried out to establish this structure.

It can be seen in Fig. 4, which corresponds to an aluminosilicate obtained from rice husk, digested with AlCl_3 and pyrolysed at 1400°C , that the product is in fibrous form. Therefore, the spherical particulates formed above are different from both chemical and textural points of view.

The diameter of these particulates vary from 0.05 to 0.12 mm; the central white portion being 0.12 to 0.04 mm in diameter. The diameter of the alumina

particulates formed from saw dust is in the range 0.25-0.37mm, while the cellulose-based alumina particulate has the diameter 0.34 mm.

Acknowledgements

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Infrared Spectroscopic Studies of Dissolving Bagasse Pulp

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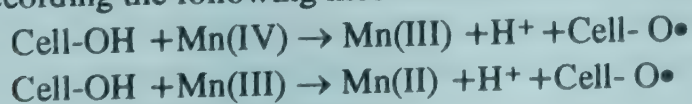
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The infrared spectra of grafted dissolving bagasse pulp with acrylonitrile using KMnO_4 / oxalic acid redox initiator system were recorded in the region of $600\text{--}4000\text{ cm}^{-1}$. The optimum monomer concentration, reaction time, initiator concentration, acid concentration and reaction temperature were confirmed spectroscopically giving information about the mechanism of grafting process.

Introduction

Graft copolymerization onto cellulose has evoked considerable interest to scientists and technologists, as it provides an effective means for synthesizing a series of new products with highly prized properties. The industries based on cellulose raw materials were quick to see potential advantages in the chemical combination of a polar cellulose with non-polar vinyl polymer^{1,2}. By grafting, polymer branches can be created to the cellulose backbone without destroying the desirable properties of the original cellulose fibers. Graft copolymerization has been applied to a number of cellulosic materials, including cotton, rayon, paper, cellophane and wood³.

Activation of cellulose, that is introduction of active centers into the cellulose molecule, has been successfully achieved by a number of chemical means. The mechanisms proposed for graft initiation and chain growth have been either free radical or ionically based. Free radicals capable to initiating graft polymerization may be introduced into cellulose by various chemical methods. One of the best method to produce the radicals is the use of redox system such as KMnO_4 /oxalic acid as discussed in our previous paper⁴. The radical which attacks cellulose, forming cellulose macroradical, may be formed according the following mechanism⁵ :



Infrared spectral analysis has been adopted to prove grafting by making use of the variation in intensity of the hydroxyl infrared absorption bands that may occur due to grafting⁶⁻⁸. As a part of our ongoing in this area, the aim of the present investigation is to determine the different factors affecting the grafting process of dissolving bagasse pulp using infrared spectroscopic technique.

Experimental

The raw material used in this work was bagasse dissolving bleached pulp prepared from depithed Egyptian bagasse by prehydrolysis soda process. The main constituents of bagasse are: α -cellulose 82.2 per cent pentosans 9.0 per cent. It has degree of polymerization (D.P.) 690 and reactivity (insoluble cellulose) 76.5 per cent.

Prehydrolysis, pulping, bleaching as well as the chemical analysis were carried out as described in previous work⁹. Grafting of bleached pulp was taken place as given in Ref.⁴. Standard polymerization conditions were : 1 ml acrylonitrile per one gram pulp, 0.06 N KMnO_4 solution, 0.05 N oxalic acid solution, reaction temperature 50°C and reaction time 1 hour.

The infrared spectra of the previously grafted pulp were obtained using IR-500 spectrophotometer, Buck Scientific INC., KBr disk technique.

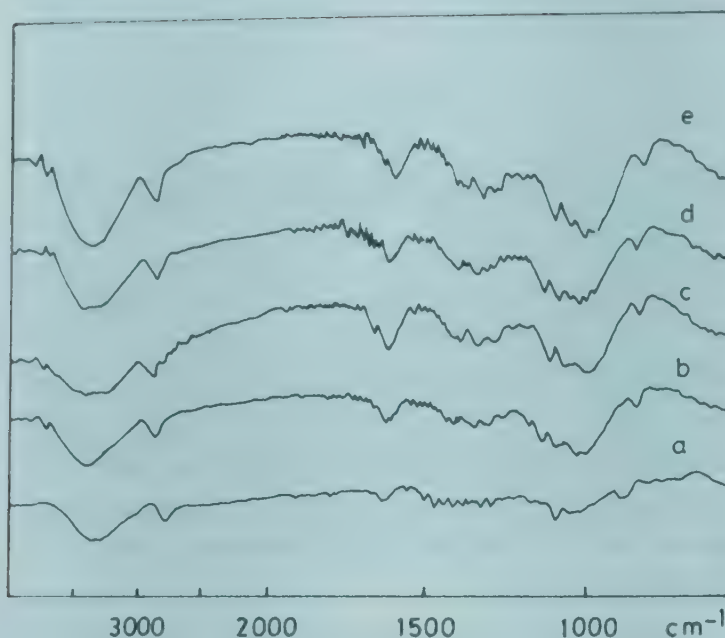


Fig.1 — IR spectra of grafted bagasse: (a) 0.00 ml AN, (b) 0.75 ml AN, (c) 1.00 ml AN, (d) 1.25 ml AN and (e) 1.50 ml AN.

Results and Discussion

Infrared spectroscopy is known to be one of many available methods of physical measurements which has been widely applied in the field of cellulose chemistry. The examination of the infrared absorption spectrum of ungrafted bagasse is an important part in the process of investigation of the effect of acrylonitrile concentration as a monomer, KMnO_4 and oxalic acid concentrations, reaction time and the temperature of reaction on the grafting process.

Fig. 1 shows the spectrum of bagasse before any chemical or physical treatment. The spectrum is characterized by appearance of a strong and broad band at 3380 cm^{-1} which is attributed to the stretching vibration of OH group. Another broad and medium band appear at 2890 cm^{-1} which correspond to intramolecular H-bonded -OH in bagasse, the lower the frequency the stronger the H-bond [10]. This is supported by appearing of a weak band at 1620 cm^{-1} due to the bending vibration of hydroxyl group because of adsorption of water on dry cellulose. Series of weak bands are observed in the range $1440\text{--}1300\text{ cm}^{-1}$ which attribute to bending vibration of CH_2 group. A medium band at 1150 cm^{-1} is due to the stretching vibration of C-OH carboxylic band. The band at 1040 cm^{-1} is probably due to C=O stretching vibration in cellulose / hemicelluloses and at 885 cm^{-1} could be the well known C, group frequency related to configurations at C, in the pyranose ring.

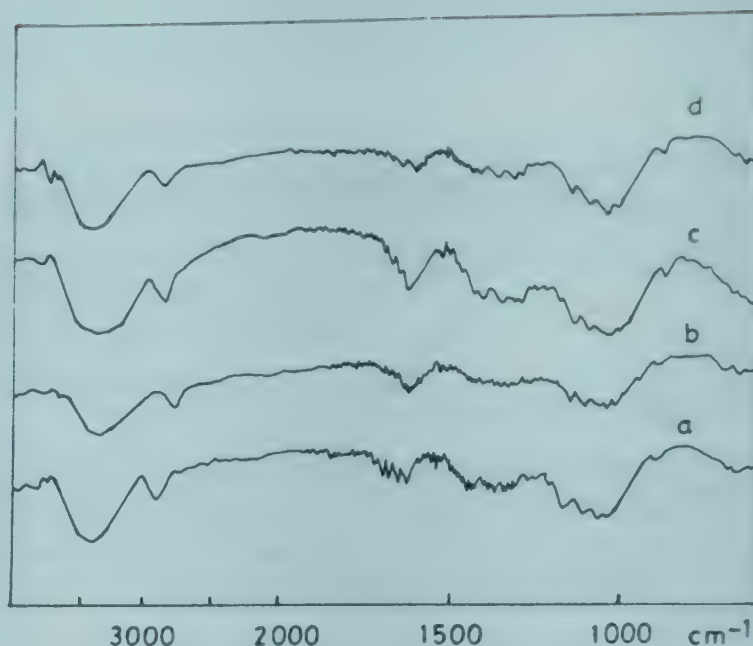


Fig.2 — IR spectra of grafted bagasse: (a) 0.04 M KMnO_4 , (b) 0.06 M KMnO_4 , (c) 0.08 M KMnO_4 and (d) 0.10 M KMnO_4 .

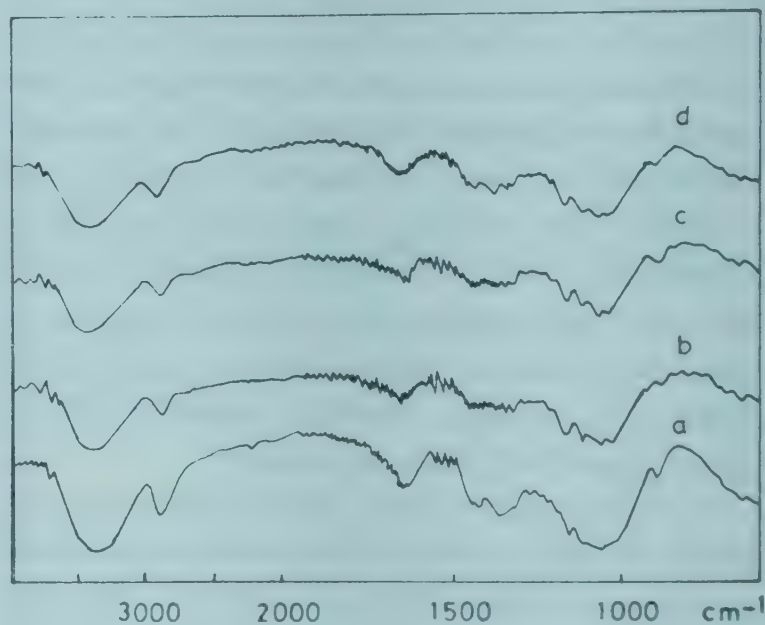


Fig.3 — IR spectra of grafted bagasse: (a) 0.03 N oxalic acid, (b) 0.05 N oxalic acid, (c) 0.07 N oxalic acid and (d) 0.10 N oxalic acid

To show the effect of acrylonitrile concentration (0.75-1.50 ml AN/1 g pulp) on the grafting polymerization, the infrared spectra of grafted samples were measured and compared with that of ungrafted bagasse. From Fig. 1, it is clear that a new band appear at 1650 cm^{-1} which attributed to the interaction of acrylonitrile monomer and OH group of bagasse forming carbonyl group. The intensity of this band increased with increasing the amount of AN added. However, the optimum monomer concentra-

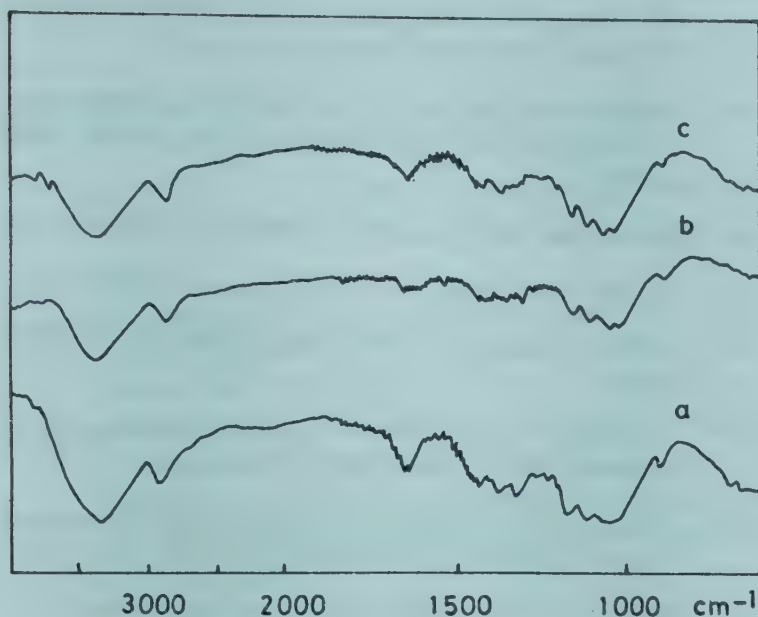


Fig. 4 — IR spectra of grafted bagasse after: (a) 30 min., (b) 90 min. and (c) 120 min.

tion was found to be 1.00 ml AN/1 g pulp (maximum CO band intensity). This behavior can be attributed to the enhanced formation of homopolymer.

The effect of KMnO_4 as an initiator on grafting polymerization of acrylonitrile onto bagasse can be summarized in Fig. 2. The concentration of KMnO_4 ranged from 0.04 to 0.10 M. It is apparent that the increase of permanganate concentration leads to increase the intensity of carbonyl stretching vibration, i.e., increase the grafting efficiency. However, at high concentration of permanganate, greater than 0.08 M, the intensity of CO group is again decreased, i.e., the amount of the graft formation is lowered. The reason for this is that at higher permanganate concentrations, extensive homopolymerization takes place at the expense of grafting which impedes the diffusion of acrylonitrile (monomer) from the aqueous solution of the fiber surface¹¹.

Fig. 3 illustrates the effect of oxalic acid concentration (0.03-0.10 N) on the polymerization process. It is obvious that the polymerization is reduced with raising the acid content. At high acid concentration manganese dioxide needed for the production of initiating species is consumed in the undesirable side reaction.



Secondly, coagulation of colloidal homopolymer increases at lower pH values retarding the diffusion of both monomer (acrylonitrile) and initiator (per-

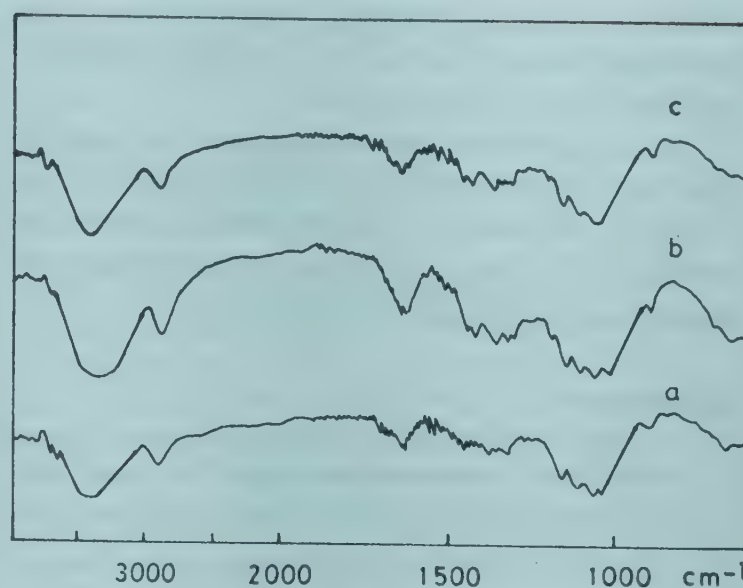


Fig. 5 — IR spectra of grafted bagasse at: (a) 300°C, (b) 400°C and (c) 600°C.

manganate) into the fiber. Consequently, the best concentration of oxalic acid in the grafting of bagasse under investigation is 0.03 N.

Fig. 4 demonstrates the effect of time on the grafting process. The infrared spectra indicates that the increasing of grafting time from 30 to 90 minutes leads to the decrease the intensity of carbonyl stretching vibration, i.e., decrease of the grafting efficiency as indicated in our previous paper⁴. The leveling off of grafting process of bagasse with time can be attributed to the reduction in concentration of both acrylonitrile and permanganate as the polymerization proceeds. The maximum intensity of carbonyl group was observed after 30 minutes grafting.

It is known that the increase in the temperature may enhance the efficiency of grafting process. The effect of raising the temperature of the polymerization system studied from 30°C to 60°C was recorded in Fig. 5. Increasing the temperature from 30°C to 40°C causes a significant increase in the grafting efficiency owing to the increase of monomer solubility and the rate of diffusion of both monomer and initiator. Further increase in the temperature cause a decrease in the grafting formation due to the oxidation of some created free radicals as well as the exothermic character of the polymerization.

It is clear from the above discussion that the results obtained from the infrared spectra, on a base of studying the intensity of carbonyl stretching vibra-

tions, are confirmed with our finding⁴, in which the grafting efficiency and polymer loading were measured by analytical techniques.

In the light of the above discussion, the optimum conditions of grafting bagasse can be summarized as : 1.00 ml acrylonitrile/1 g pulp, 0.08 M KMnO₄ as initiator, 0.03 N oxalic acid, the time of grafting is 30 minutes and the temperature is 40°C.

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Studies on Alkaper-AQ Pulping of Wheat Straw

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The pulping of wheat straw has been carried out by alkali-peroxide-anthraquinone (AQ) delignification process. The experiments have also been conducted with soda, soda-AQ, and kraft pulping process. The experimental results indicated that with almost same cooking conditions and equivalent alkali dose all these processes can acquire pulps with almost same permanganate number, but their screen yield, optical characteristics, physical strength properties and environmental pollution load of the process are entirely different. The over-all pulp characteristics of peroxide-alkali (PA process) was found to be comparatively superior in comparison the all other pulping processes studied. The addition of hydrogen peroxide during pulping enhances the selectivity of delignification along with less degradation/deterioration of the pulp fibers.

Introduction

Cellulosic fibres are produced through permanent growth of not trees but also of large number of non-woody plants including agricultural residues. The non-woody plants represent one of the major source of fibrous raw material for many developing nations of the world. In some countries especially where wood is scarce, non-woody fibres are consequently more common as raw materials to be used for pulp, paper and board manufacture.

With the tremendous increase in population and literacy, the planning commission has indicated the capacity creation of paper and board products will need to be increased to about 42.5 lakh tonnes by the end of this century. The biggest bottle neck in meeting the targeted amount of paper and board products will be the availability of cellulosic raw materials from existing forests resources which are already in short supply and are barely able to sustain the present level of production. To meet the increasing demand of paper and board products, the requirement of fibrous raw material is increasing day by day, which is affecting the environment and natural ecosystem to conserve forest which is so essential for a stable eco-balance. Therefore, it is very much essential that in the developing nations, where the forest cover is already below the required level, the main emphasis should be given on the utilization of agriculture residues for the production of high and ultra high yield pulps with the latest environmental pollution load in the biosphere.

The structure of the group of the non-woody fibrous raw materials in India is significantly different from that of other countries and regions of the world, since in India bamboo along with other non-woody fibres including agricultural residues are the most important raw material for pulp and paper making.

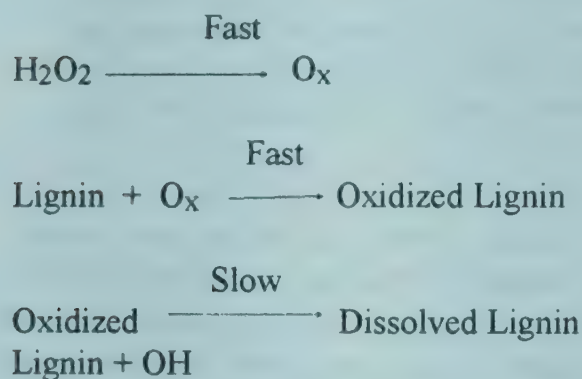
The availability of straw is closely linked with grain production. Of the huge quantity of straw available after grain collection, a very small amount is used for cattle fodder. Most of the straw is burned or plowed back to supply humus and soil nutrients. The price of straw in the field is almost nothing compared to the expenses for baling, transportation and storage. Abundant quantities of straw are therefore available for pulp production. In rural areas straw collection for industrial use provides addition earnings for land owners and employment opportunities for many unoccupied farm hands.

The use of cereal straw for pulping is of great interest to the most of the developing countries, where availability of pulp wood is limited. India is one of the major wheat straw producing country in the world, with an estimated 50 million tonnes available wheat straw production. Moreover, the open structure and low lignin content of cereal straw make its chemical processing relatively easy in particular by Alkaper process.

The use of anthraquinone (AQ) in alkaline pulping has become one of the most intensely pursued research topics in recent years. Numerous studies¹⁻⁴ revealed that the delignification process (with AQ), though simple and efficient, but on the other hand have certain draw backs, such as lower pulp strength (of major concern in softwood pulps), interior pulp

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bleachability and higher production cost, because of the significant amount of AQ consumption. The drawbacks can be traced to the excess amount of AQ used in order to get a bleachable grade pulp with less degradation of carbohydrate fraction at the end of the cook. In order to reach a still lower Kappa number of pulp, an additional delignifying agent has to be used. Hydrogen peroxide in alkaline medium achieve this goal advantageously^{5,6}. The delignification process with H_2O_2 is most likely the result of following reactions:



The first step of delignification seems to be the fast oxidation of the lignin by the O_x components [$(OH^\cdot)$, $(O^\cdot)$, $(O_2^\cdot)$]. The second step would be slow dissolution of the oxidized lignin in alkaline medium. This explains the fast disappearance of the hydrogen peroxide and accounts for the lack of effect displayed by the sodium silicate. It has been found that in certain cases pulp quality was increased by the addition of $MgSO_4$ (Magnesium Sulphate). The later decrease the attack of the chemicals on depolymerisation of cellulosic fibre.

In the following a process which allowing chemical pulping without addition of sulphur compounds is dealt with. The process not only eliminates the production of pollutants but also increase the pulping efficiency by 5 to 10%. The idea is to combine the catalytic effect of AQ and its derivatives and the delignifying capability of hydrogen peroxide into one stage and two stage processes. The two stage pulping process involving a first stage of conventional soda pulping at a lower alkali dose producing a high yield pulp with high Kappa number followed by second stage using the residual alkali alongwith hydrogen peroxide.

Experimental Methodology

Raw material preparation and analysis

The air dried wheat straw was collected from a local farm house of Saharanpur District. The wheat

straw was chemically analyzed by TAPPI Standard method. The chemical composition of wheat straw is indicated in Table-1.

The morphological studies of different fractions of wheat straw was done by Bureau of Indian Standard method IS 5285-1969, and the dimensional characteristic of wheat straw fractions are given in Table-2.

Pulping Studies

Prior to pulping the wheat straw was washed with water, in order to remove the dirt and other foreign materials, and dried in air.

The pulping studies were conducted in a WEVERK electrically heated rotatory digester of $0.02m^3$ capacity having 4 stainless steel bombs of 1 liter capacity, furnishing sufficient pulp for evaluation. During the course of pulping, the bath ratio of 1:5 was maintained and following time schedule for digester heating was used.

When temperature reaches $105^\circ C$ the pressure was released by venting off. At the end of the cook the charge was blown from the digester. The pulp was washed on a laboratory flat stationary screen having 300 mesh wire bottom for the removal of residual cooking chemicals. The pulp was further disintegrated in the laboratory disintegrator. The disintegrated pulp was further screened through a vibratory flat screen and the screened pulp was further evaluated.

The cookings were carried out by soda, soda-AQ, kraft, alkali AQ-peroxide (single stage) and Alkali-AQ-peroxide (two stage pulping method). The results of soda pulping at different alkali doses have been mentioned in Table-3. The results of the varying doses of AQ during soda pulping have been mentioned in Table-4 and the results of kraft pulping at equal active charge have been mentioned in Table-5.

Peroxide-alkali Pulping

Basically, the peroxide alkali (PA process of single stage pulping studies on wheat straw conducted at following conditions using varying doses of peroxide. (The results are tabulated in Table-6).

Active Alkali	11
AQ dose, %	0.1
Cooking temperature, $^\circ C$	160
Bath Ratio	1:5
H_2O_2 , %	0.5, 1.0, 1.5
Na_2SiO_3 , %	3
$MgSO_4$, %	0.5
EDTA, %	0.25

Table 1—Proximate Chemical Analysis of Wheat Straw

Sl. No.	Particulars	Percentage values on O.D. basis
1	Cold water solubles	7.8
2	Hot water solubles	10.8
3	1% NaOH solubles	38.8
4	Alcohol-Benzene Solubles (1:2 v/v)	4.8
5	Lignin	16.2
6	Holocellulose	72.5
7	Alpha Cellulose	37.8
8	Pentosans	28.9
9	Ash	5.3
10	Silica	2.8

Table 2—Morphological Characteristics of Wheat Straw

Sl. No.	Fibre dimensions	Values		
		Max.	Min.	Average
1	Fibre length, mm	1.28	0.85	1.15
2	Fibre Width micron	22.0	17.4	20.5
3	Lumen Width, micron	7.0	5.4	6.1
4	L/D Ratio	116.36	97.70	112.19

Table 3—Experimental Results of Soda Pulping of Wheat Straw at different doses of alkali (Raw material to liquor ratio : 1:5; Time to temperature, °C : 160; Time at maximum temp. min. : 60)

Sl. No.	Particulars	Alkali doses, % (as Na ₂ O)		
		9	11	13
1	Permanganate Number	22	17	16
2	Unscreened Pulp Yield, %	54	48	48.3
3	Rejects, %	13	1.8	1.7
4	Screened Pulp Yield, %	41	46.2	46.6
5	Brightness, % (Elrepho)	20	23	24
6	Tensile Index	41.2	46.5	46.7
7	Tear Index	2.75	4.0	4.1
8	Burst Index	1.90	2.75	2.78

Table 4—Experimental Results of Soda-AQ Pulping of Wheat Straw at different doses of AQ (Alkali dose, % (as Na₂O) 11; Raw material to liquor ratio 1:5; Time to temperature, min. 120; Maximum temperature, °C 160; Time at maximum temperature, min. 60)

Sl. No.	Particulars	Doses of AQ % (O.D. Raw Material Basis)			
		0.0	0.05	0.1	0.2
1	Permanganate Number	17	14	12	11.8
2	Unbleached Pulp Yield, %	48	50.4	51.0	51.2
3	Rejects, %	1.8	2.6	2.7	2.8
4	Screened Pulp Yield, %	46.2	47.8	48.3	48.4
5	Brightness, % (Elrepho)	23	24	25	25
6	Tensile Index	46.5	47.0	47.5	47.6
7	Tear Index	4.0	4.42	4.55	4.58
8	Burst Index	2.75	2.84	2.90	2.91

Table 5—Experimental Results of Kraft Pulping of Wheat Straw (Active alkali, % as Na₂O 11; Sulphidity, % 18; Raw material to liquor ratio 1:5; Time to temperature, min. 120; Maximum temperature, °C 160; Time at maximum temperature min. 60)

Sl. No.	Particulars	Values
1	Permanganate Number	12.8
2	Unscreened Pulp Yield, %	51.6
3	Rejects, %	3.0
4	Screened Pulp Yield, %	48.6
5	Brightness, % (Elrepho)	22
6	Tensile Index	51.8
7	Tear Index	6.2
8	Burst Index	3.17

Table 6—Experimental Results of Peroxide-Alkali (PA-One State) Pulping of Wheat Straw at different doses of H₂O₂

Sl. No.	Particulars	Dose Values, %		
		0.5	1.0	1.5
1	Doses of H ₂ O ₂	0.5	1.0	1.5
2	Permanganate Number	14.3	12.2	53.8
3	Pulp Yield (Unscreened), %	54.2	53.5	53.8
4	Rejects, %	2.2	1.0	1.2
5	Pulp Yield (Screened), %	52.0	52.5	52.6
6	Brightness, % (Elrepho)	32	35	35.5
7	Tensile Index	68.5	71.0	71.2
8	Tear Index	6.0	6.6	6.70
9	Burst Index	4.0	4.90	4.95

Table 7—Experimental Results of Alkali-Peroxide (AP-Two Stage) Pulping of Wheat Straw.

Sl. No.	Particulars	Values
1	Alkali dose, % (as Na ₂ O) (I-Stage)	9.0
2	Pulp Yield, (Unscreened), %	54
3	Permanganate Number	22
4	Residual alkali dose, % (as Na ₂ O ₂) (II-Stage)	2
5	H ₂ O ₂ dose, %	1
6	Pulp Yield (Unscreened), %	51.6
7	Rejects, %	1.8
8	Pulp Yield (Screened), %	49.8
9	Permanganate Number	14.2
10	Brightness, % (Elrepho)	31
11	Tensile Index	62.5
12	Tear Index	6.4
13	Burst Index	4.5

Time to maximum

temperature: 120 min.

Time at maximum temperature: 60 min.

Alcaper Process

This process is carried out as 2-stage AP, therein the wheat straw was cooked by Alcaper process, which is a combination of the two stages (partially delignified wheat straw was further treated with hydrogen peroxide in alkaline medium).

(a) The wheat straw was cooked with 9% alkali dose at 160°C to get partially delignified pulp having high permanganate number.

(b) The partially delignified wheat straw pulp was treated with hydrogen peroxide in alkaline medium at atmospheric pressure at a temperature of 90°C having a medium consistency of around 10% to 12% at following conditions.

1st Stage

Alkali dose, %	9
Bath ratio	1:5
Cooking temperature, °C	160
Time to maximum temperature	160 min.
Time at maximum temperature	60 min.

2nd Stage

Residual Alkali dose, %	2
Bath ratio	1:5
AQ, %	1
H ₂ O ₂ , %	1
MgSO ₄ , %	0.5
Na ₂ SiO ₃ , %	3
DTA, %	25

The experimental results are shown in Table 7.

Pulp Evaluation

The wheat straw pulp made by various methods were beaten in a PFI mill with a beating pressure of 1.8 kgs/cm. to 40°SR freeness levels and handsheets of 60 gms/cm² were prepared on a standard British Sheet Forming Machine. These handsheets were evaluated as per BIS standard methods for their physical strength properties at a relative humidity of 65±2% and at a temperature of 27±2°C. The pulp yield and pulp characteristics of the pulps have been compared and the results are tabulated in Table 3-7 and shown in Figs.1-3.

Results & Discussions

The five main important botanical parts of wheat straw includes, nodes, internodes, leaves, ears and rachis in weight percentage proportions of 7%, 52%, 20%, 12% and 9% respectively.

The results of proximate chemical analysis of wheat straw (Table-1) indicate that the total carbohydrate fraction (holocellulose) is approximately equal to that of hardwoods. The wheat straw has higher hemicellulose content (mainly pentosans) and low lignin content as compared to woods. The shnd silica contents are relatively high and much of silica is concentrated in the leaves and ears.

The results of morphological analysis of wheat straw showed that the wheat straw fibers are principally derived from the bast cells and they are fairly long (0.85-1.28 mm). Fibers with narrow lumen are slender and thick walled with sharply pointed ends. Approximately 40% of the cells in straw are fibers and remaining 60% of the cells consists of parenchyma, epidermis cells, vessels and spirals. The average fiber length is about 1.15 mm but the fiber width varies from 17.4 to 22.0 micron.

To determine the optimum pulping conditions. It is necessary to know the influence of different variables on pulp yield, permanganate number, optical properties and other physical strength properties of paper hand sheet.

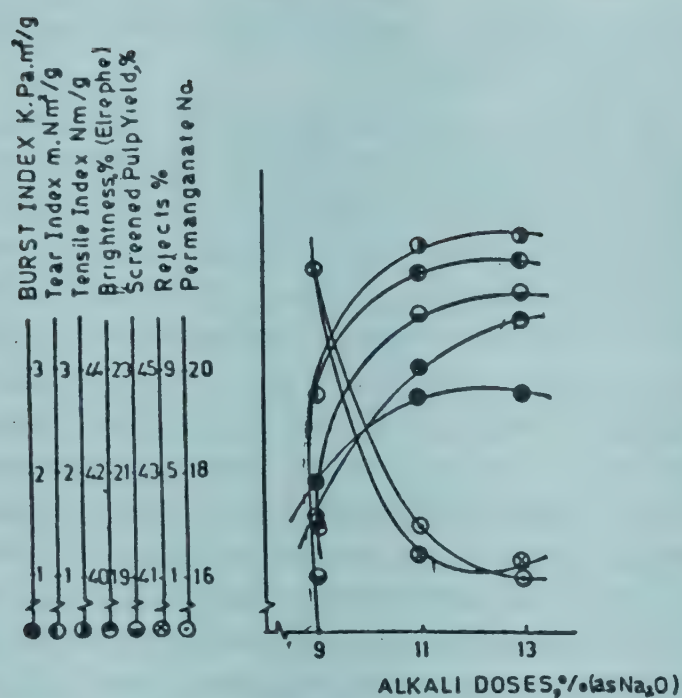


Fig. 1.—Plots of alkali doses versus pulp characteristics

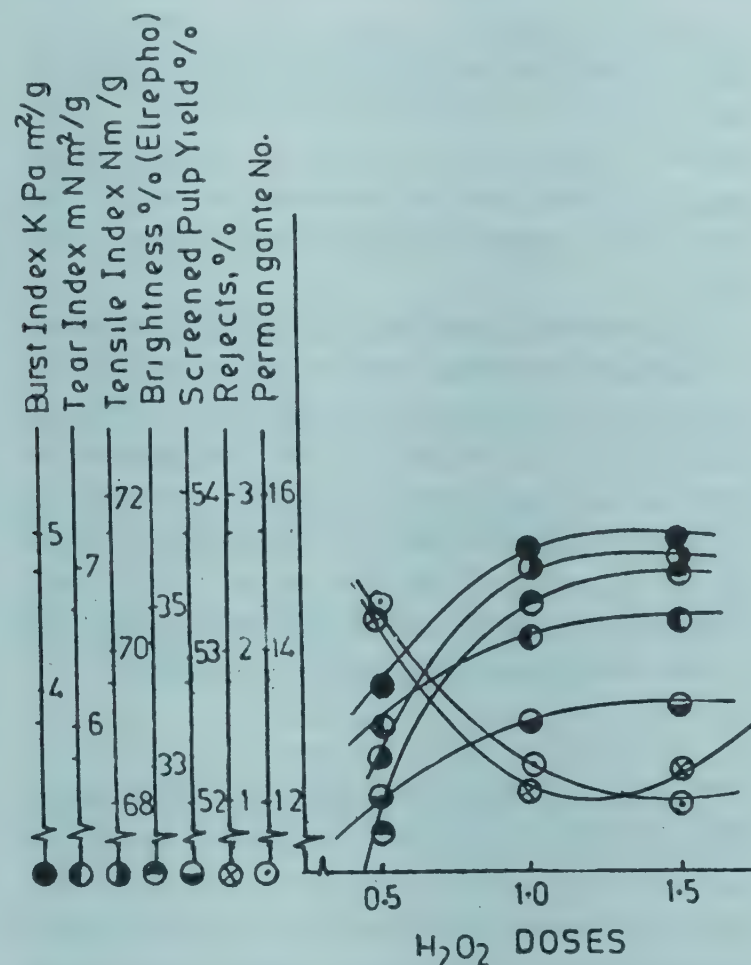


Fig. 3.—Plots of hydrogen peroxide doses versus pulp characteristics

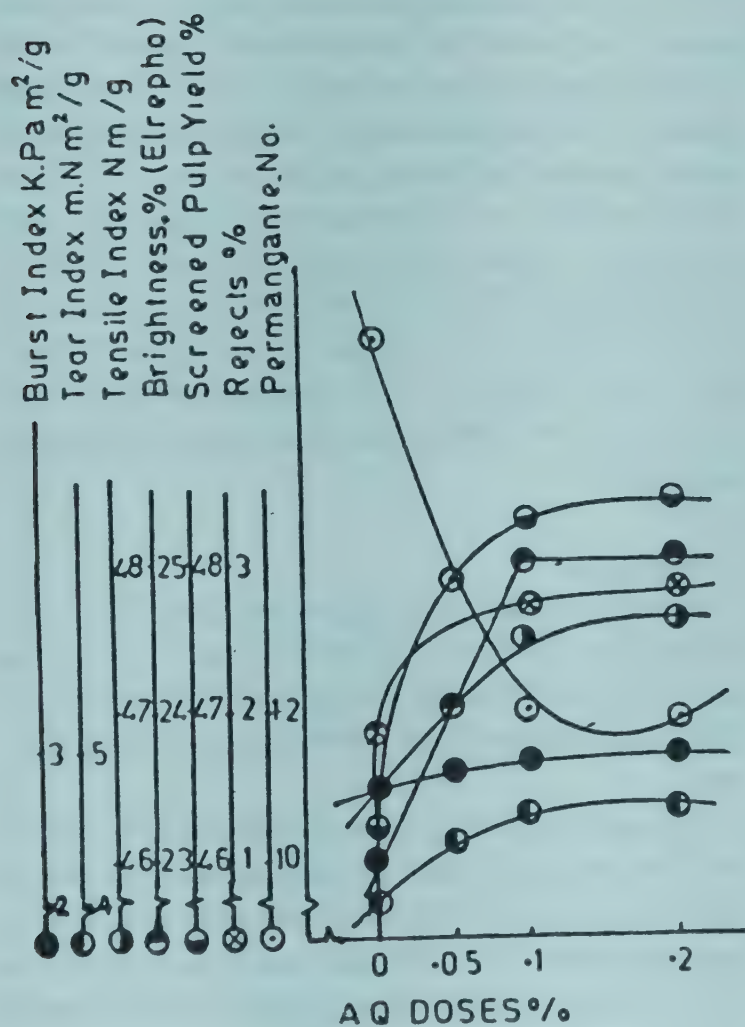


Fig. 2.—Plots of AQ doses versus pulp characteristics

To get the optimum dose of alkali, the experiments were conducted at an alkali doses 9%, 11%, and 13%, keeping the bath ratio, time to temperature, maximum temperature, and time at maximum temperature parameters constant at 1:5, 120 minutes, 160°C and 60 minutes respectively. These experimental results (Table-3 and Fig.1) indicated that overall properties of pulp improved a lot at an alkali dose of 11% in comparison to the pulp properties at 9% alkali dose but when the alkali doses were further increased to 13%, there is not much improvements in overall pulp properties. Therefore, an alkali dose of 11% may be considered as optimum, for the pulping of wheat straw.

To know the effect of anthraquinone (AQ) the experiments were conducted at different doses of AQ (viz 0.0%, 0.05%, 0.1% and 0.2%), keeping all other parameters like alkali dose (11%), bath ratio (1:5), time to temperature (120 min.), maximum temperature (160°C) and time at maximum temperature (60 minutes) constant. The experimental results (Table-4 and Fig.-2) indicated that the optimum AQ charge was found to be 0.1%, owing to its influence on screened pulp yield and overall pulp characteristics.

Although at higher AQ dose, beyond 0.1% level, the rate of delignification and screened pulp yield increases only slightly, but that could not be justified economically and moreover it exceeds the FDA regulated limit of 0.1% AQ on O.D. wheat straw. Additionally, some improvements in the overall strength properties have also been observed, by the presence of AQ with regard to plain soda pulping of wheat straw.

To compare the soda and soda-AQ pulps vis-a-vis to kraft pulp, the wheat straw was also pulped by the kraft process at the same active alkali dose (11%) and sulphidity (18%), keeping all other parameters constants as mentioned in the case of soda, and soda-AQ pulping of wheat straw. The experimental results (Table-5) indicated that the overall pulp characteristics are superior to soda pulping but quite comparable with soda-AQ pulping of wheat straw.

To know the effect of hydrogen peroxide during alkaline delignification of wheat straw, the experiments were also conducted by peroxide-alkali (PA-one stage) process as well as alkali-peroxide (AP-two stage) process (Tables-6 and 7 respectively). During PA pulping studies, the experiments were conducted at different doses of hydrogen peroxide (viz, 0.5, 1.0 and 1.5%). On comparing the experimental results (Table-6 and figure-3) conducted at different doses of hydrogen peroxide, these results clearly indicated the overall pulp characteristics of PA process conducted at 1% hydrogen peroxide dose have been improved a lot in comparison to pulp characteristics obtained at 0.5% hydrogen peroxide level.

On further increasing the dose of hydrogen peroxide from 1.0% to 1.5% level, the improvement in overall pulp characteristics was found to be very meager, which could not be justified economically, considering the high cost of hydrogen peroxide. Considering the overall pulp characteristics at different level of hydrogen peroxide doses; a 1% hydrogen peroxide dose level may be considered as optimum level to get the overall better pulp characteristics.

The wheat straw was also pulped by alkali-peroxide (AP-two stage) process. the partially delignified pulp with high permanganate number was further treated with hydrogen peroxide under alkaline conditions, the results are tabulated in Table-7.

On comparing the results of AP-two stage pulping process vis-a-vis to PA-one stage pulping process; it has been clearly indicated that the AP-one stage pulping process is superior to PA-two stage pulping process in many respects.

On further comparing the overall pulp characteristics of soda-AQ, kraft, PA-one stage process and AP-two stage pulping processes, the results indicated that with the almost same cooking conditions and equivalent alkali dose, all these process can acquire pulps with about the same permanganate number, but their screened yields, optical and other pulp characteristics are entirely different, the pulp yield along with other optical and physical strength properties of PA-one stage pulping process was found to be comparatively superior in comparison to those of soda-AQ, kraft and AP-two stage pulping process, the contrast indicate that the addition of hydrogen peroxide during pulping enhance the selectivity of delignification with less degradation/deterioration of pulp fibers.

As usual, during the course of delignification, the delignification reaction can be approximated into three phases. Before cooking temperature reached 100°C, is the bulk delignification phase. During this phase the degree of delignification/or extent of lignin removal reached approximately 67%. The second phase is the supplementary delignification phase, which includes the heating up period from 100°C to 160°C and time at temperature or cooking time; and during this phase, the extent of lignin removal reached about 90%. The time beyond cooking time or time at temp., is the residual delignification phase, where the extent of total removal of lignin approached to 93-94% of the total lignin available in raw material.

Conclusions

In comparison to all pulping method studied for the pulping of wheat straw, the PA-one stage pulping processes was found to be superior in comparison to soda, soda-AQ kraft and AP-two stage pulping process.

The addition of AQ led to a significant increase in screened pulp yield and rate of delignification, due to stabilization of carbohydrates towards end wise degradation. Addition of AQ may be economically beneficial due to increase in pulp yield, improvement in overall strength properties and shorter cooking time.

Gaseous evolved by a pulp mill using the alkali-peroxide process are completely free of sulphur com-

ponents. This is a definite advantage as sulphur odours are a major complaint in neighbourhoods of kraft mills. Eradication of sulphur air pollutants is one of the major important advantages of the alkali-peroxide process, because no other system today can achieve great improvements in this area. This the cost of air pollution control system may be saved while on the other hand much more satisfactory results may be obtained on commercial scale.

Regarding recovery of chemicals, only caustic soda has to be recovered, which means new combustion and causticizing techniques can be used, such as fluidized-bed smelt causticizing technique.

The production cost of an alkali-peroxide pulp will probably be similar to that of kraft pulp; since the cost of AQ, H_2O_2 and extra soda used is offset by the increase in pulp yield with improved brightness alongwith decrease in maintenance cost due to less corrosive nature of soda liquor compared to kraft liquor.

The alkali-peroxide pulping process is a desirable alternative to the kraft process.

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Jinghan - A Partial Substitute for 'Jigat' in Agarbathi Manufacture

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Agarbathi making is one of the oldest and prominent cottage industries providing employment to weaker sections of both urban and rural people, especially women. Total production of agarbathi in the country during 1992-93 in terms of value was about Rs. 150 crores. Exports of Agarbathi fetched Rs. 49.1 crores during 1994-95 of which 80% is from Southern region. Production and export performance of agarbathi industry depends on availability of forest based raw materials viz., bamboo, charcoal, 'jigat', sandalwood, Halmaddi etc. Indiscriminate collection is leading to overexploitation and shortage of raw materials particularly, 'Jigat' - the basic binding material which is the bark of slow growing evergreen tree *Machilus macrantha*. Amongst the various plant materials screened, *Lannea coromandelica* syn. *Odina woder* (Moyna or Jinghan) gum in combination with 'Jigat' in 1:1 ratio was found to be a good partial substitute and agarbathis rolled using this mixture costs 20 per cent less than those rolled with pure 'jigat'.

Introduction

Burning of Agarbathi (incense or joss sticks) is an essential element in the performance of religious rites and social functions. Agarbathi as air freshener, masking agent or disinfectant is gaining importance, helping export of this commodity. It is one of the oldest and labour-oriented cottage industries providing employment to weaker sections of both urban and rural people, especially women. Bangalore and Mysore (Karnataka) are two major production centres for agarbathi in the country today. While 90% of raw bathis are made here, Karnataka State accounts for nearly 60% of the agarbathi industry in India. The total production of agarbathi in the country during 1992-93 in terms of value was about Rs. 150 crores and exports fetched Rs. 49.1 crores during 1994-95 according to latest available statistics. More than 80% of agarbathi export is from Southern India.

Agarbathi making is entirely manual and is carried out mostly by women using 'jigat', charcoal, sandal dust, perfumery materials and bamboo splints.

'Jigat' is the trade name for the adhesive binding material- bark of *Machilus macrantha*, a slow growing evergreen tree of Western Ghats and high rainfall areas in Karnataka. Due to expansion of agarbathi industry, there is growing demand for jigat, leading

to continuous debarking of standing trees and this has resulted in depletion of many trees, which are found to grow mostly in evergreen or semi-evergreen forests of Western ghats.

Requirement of 'Jigat' for 1991-92 was of the order of 3000 tonnes. With growth of agarbathi industries anticipated requirement per annum is around 8000 tonnes which is likely to reach 12000 tonnes by turn of the century. *Machilus macrantha* being a slow growing tree, even if a commercial plantation is raised to cater to the needs of the industry, it will take 20 to 30 years to grow to required girths for exploitation of bark. Hence, a survey of plant materials was undertaken to find out a suitable substitute which is a supporter of combustion, possessing binding, keeping, burning and odour diffusing properties similar to 'jigat'.¹⁻⁴

Material and Methods

Twenty plant materials were collected from commercial and forest sources and screened after cleaning, purifying and drying.

Bark, gums, fruits and seeds tried as substitute for 'Jigat'.

(i) *Acacia arabica* (gum)

(ii) *Acacia catechu* (gum)

- (iii) *Acacia senegal* (gum)
- (iv) *Acrocarpus fraxinifolius* (bark)
- (v) *Anogeissus latifolia* (bark)
- (vi) *Anogesissus latifolia* (gum)
- (vii) *Aracaria cunninghamii* (bark)
- (viii) *Boswellia serrata* (gum)
- (ix) *Bauhinia variegata* (bark)
- (x) *Commiphora wightii* (gum)
- (xi) *Cordia dichotoma* (fruit gum)
- (xii) *Cyanopsis tetragonolobus* (guar) (seed gum)
- (xiii) *Grevillea robusta* (bark)
- (xiv) *Grewia tiliaefolia* (bark)
- (xv) *Hibiscus esculentus* (fruit gum)
- (xvi) *Lannea coromandelica* syn. *odina wodier*
(Moyna or Jinghan gum)
- (xvii) *Plantago ovata* (seed gum)
- (xviii) *Prosopis juliflora* (gum)
- (xix) *Pterocarpus marsupium* (bark)
- (xx) *Sterculia urens* (gum)

These materials were powdered and experimented upon individually by mixing with different ratios of 'jigat' powder viz., 100:25, 100:50; 100:75 and 100:100 respectively. This mixture referred as 'substitute material' was used in making agarbathis by both the methods.

Method 1 (Dipping)

Substitute materials, charcoal and dust of sapwood of sandal in ratio of 6:5:1 were mixed with water to a dough like adhesive mass. it is taken on a wooden plank, rolled manually onto bamboo splints using 'Nurva' powder (mixture of 400 gms charcoal and 600 gms of dust of sapwood). Rolled bathis are dried in shade for two days and then dipped in a mixture of perfumery diluted with a solvent (diethyl phthalate, dibutyl phthalate, phenylethyl alcohol or paraffin). From one kg. of dough, about 1000 bathis of 25 cm length and 2 mm dia. can be rolled.

Method 2 (Masala)

Substitute material, charcoal, dust of sapwood and perfumery materials in ratio of 1:1:2:1 were mixed, agarbathis rolled and dried as above. Agarbathi sticks prepared and dried in shade were tested in collaboration with agarbathi manufacturers.

Results and Discussion

Gums of *Lannea coromandelica* syn. *Odina wodier* (Jinghan or Moyna) and *Anogeissus latifolia* (Dawda or Ghatti) are identified as partial substitutes for 'jigat' in ratio of 1:1. Of these two, Jinghan was found to perform better than Dawda according to agarbathi manufacturers. Jinghan alone did not give the desired result. Dough prepared from Jinghan: Jigat (in ratio of 1:1) has to be used soon after its preparation i.e., within two hours for satisfactory results.

Gum of Jinghan can be obtained periodically by tapping *Lannea* trees by making short, oblique, shallow cuts on the trunk. On an average, single *Lannea* tree yields 5 kg. of gum in the first year of tapping, decreasing to 1 kg. in the 5th year, when the tree could be given rest. Indiscriminate debarking of *Machilus* trees ultimately results in fast depletion of the tree itself. Being a slow growing tree, *Machilus* takes about 20 years to put up sufficient bark for exploitation.

Conclusion

Jinghan gum is presently available on a small scale in Gujarat (100 tonnes) and the Girijan cooperative Corporation, Ltd., Visakhapatnam, Andhra Pradesh is also in a position to supply 500 tonnes per annum. If the market is encouraging, collection can be augmented. However, except Gujarat State no organised collection of gum is reported from any other state, despite the fact that this gum has many industrial application. Hence, a rough estimate about the potential availability of this gum from our forests if made available, can help the industry in utilising this material as a partial substitute for 'jigat' on a large scale. Ultimately it will reduce pressure on existing over-exploited *Machilus macrantha* trees to a considerable extent. Agarbathi sticks rolled from the substitute binding materials Jinghan:Jigat (1:1) mixture is 20% cheaper than those rolled with pure jigat.

Acknowledgements

Authors are thankful to Dr. V.V. Srinivasan, director, IWST, Bangalore for his encouragement and also to M/s. B.V. Aswathaiah & Bros., Bangalore for kindly arranging testing of bathis and for their evaluation.

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Note

Microencapsulation of Vanillin Using *Acacia nilotica* Gum

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The prospects of utilisation of gum from widely grown *Acacia nilotica* spp. are investigated. Microencapsulation of flavours using *A. senegal* gum, imported from African countries is a common practice. Results show that *A. nilotica* gum can ideally substitute *A. senegal* gum for microencapsulation of food flavour.

Microencapsulation as the word suggests is the encapsulation around the microscopic particles having active material in the core, surrounded by a protective sheath of the wall material. The choice of wall material(s) depends on several of factors including expected product objectives, nature of the core material, process of encapsulation, and economics. Many natural, synthetic and semi-synthetic polymers, as well as other film forming substances have been employed as wall materials in the process of microencapsulation in various fields. Among the several wall materials, true gum arabic (*Acacia senegal*) is a preferred encapsulating agent for spray dried flavours or dry cloud agents¹. Flavours spray dried with this gum have been shown to last 10 to 20-times as long as flavours air dried on a solid carrier like sugar^{2,3}.

Traditionally supplies of gum arabic have relied on native or nomadic people in a subequatorial region such as Sudan and in recent years on plantations being established in Western African countries. In India, true gum arabic is still solely imported and, therefore, a suitable substitute to it would be welcome both for local as well as international use. The polysaccharide exuded by *A. nilotica* syn. *A. arabica* trees has been shown to contain residues of D-galactose, L-arabinose, L-rhamnose, D-glucuronic acid and 4-O-methyl-D-glucuronic acid, similar to those

in *A. senegal* gum^{4,5}. The galactan framework of *A. nilotica* gum appears to be based on a branched structure of β 1--3 and β 1--6-linked galactose residues⁶. Physicochemical measurements made on the solutions of two gums have suggested that the molecules of *A. senegal* gum have a more compact structure than those of *A. arabica* gum⁶⁻⁷. Considering these facts, the present work was undertaken to explore possibility of using gum from *A. nilotica* spp. which is indigenous to western part of the Indian gangetic plains and northern parts of deccan plateau, including Andhra Pradesh, Maharashtra, Rajasthan and Gujarat for encapsulation of standard flavouring material Vanillin.

Acacia senegal gum (gum arabic, Loba chemie Pvt Ltd, Bombay), Amizo gum (American Maize Products Company, USA), Crude *Acacia nilotica* gum (Vrindavan Block of Mathura Forest Division, U P), vanillin (S M Dye Chemicals Ltd, Mumbai) and Propylene glycol (Loba Chemie Pvt Ltd, Mumbai) were used in the experiments. A laboratory mini Buchi spray drier was used for spray drying.

All gum solutions to be used as encapsulating agents were prepared at 20% (w/v) concentration by constant stirring at 98°C for 1 h. Since vanillin is not water soluble beyond 1%, its solutions were prepared using minimum amount of propylene glycol. Amount of vanillin added was 10% of the weight of

Table 1 — Spray drying condition for encapsulation of vanillin

Encapsulating gum (20 % w/v)	Drying temperature of air, °C	
	Inlet temperature	Outlet temperature
1 <i>Acacia senegal</i> gum	160±10	78±10
2 Amizo gum	115±10	75±10
3 <i>Acacia nilotica</i> gum	160±10	78±10

gum used. Spray drying conditions used for encapsulation of the flavouring material were, as shown in Table 1, 0.25 g of each sample was first washed with 25 ml absolute alcohol for estimating encapsulated vanillin and the filtrate made to 50 ml with water. The surface vanillin was estimated by dissolving the residue in distilled water and making up to 100 ml. Vanillin was estimated in 5 ml of each of these samples using Folin Denis reagent⁸ and standard curve of vanillin in the range of 0.001 mg/ml to 0.01 mg/ml.

The results (Table 2) showed *A. nilotica* gum has a slightly higher encapsulation efficiency than *A. senegal* gum and Amizo gum. However, comparative percentage recovery of flavour in *A. nilotica* gum was low, which could be attributed to its crude form. All the spray dried samples were water soluble. Hygroscopicity of spray dried powder was more for *A. senegal* and *A. nilotica* gums while Amizo gum yielded a free flowing product. These preliminary results indicate the potential of *A. nilotica* gum as a substitute for gum *A. senegal*. Systematic tapping, collection, purification and grading of the *A. nilotica* gum under hygienic conditions would improve its performance and applicability in food microencapsulation.

Table 2 — Observations on encapsulation of flavour

Encapsulating agent	Product appearance and colour	Total vanillin (%)	Encapsulated vanillin (%)	Surface vanillin (%)
1 <i>A. senegal</i>	Off white, hygroscopic powder	74.8	57.89	42.11
2 Amizo gum	White, free flowing powder	72.61	58.61	41.39
3 <i>A. nilotica</i> gum	Slight brownish, hygroscopic powder	50.60	59.39	40.61

Efficiency of gum exudate of *A. nilotica*, an untapped gum source, to microencapsulate vanillin was found to be at par with the well established wall material i.e. true gum arabic (*A. senegal*). This suggests the potential of *A. nilotica* gum as a substitute for true gum arabic being imported at present.

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BOOK REVIEWS

Dimensions of Creativity, edited by Margaret A Boden (The MIT Press, Cambridge, Massachusetts, Mass. 02142) 1996, pp 243; Price: £ 14.00 [ISBN 0 262 52219 5]

The above book is a compilation of eight chapters written by eight different authors. These are not for the layman with casual curiosity about the subject of creativity. The authors are of different backgrounds but all are highly accomplished academics. The book appears to have as target the serious minded general reader or university students studying the subject.

This book arose from project titled, 'The Achievement Project' undertaken by a research group sponsored for five years by the Renaissance Trust. The project was interdisciplinary, bringing together academics in the history of science and economics, the philosophy and sociology of science, anthropology, and psychology.

It gives numerous quotable quotes and raises numerous questions. However, like all scholarly works, this book also suffers from ambiguities and answers to most of the questions remain unclear. Many questions also remain unasked.

As expected, it starts with the basic question as to what is creativity? Some of the other questions that can be listed are as follows:

- (i) Is the creative process much the same in arts and sciences?
- (ii) Can creativity be measured?
- (iii) How do new ideas generate in the mind? Where do they come from?
- (iv) How can we measure a society's creativity?
- (v) Can only a truly creative person study creativity?
- (vi) Are there rules for discovery? Can there be a discovery without acceptance?
- (vii) What is the method of science that the brain uses?
- (viii) Which comes first, discovery or justification?

- (ix) Are there some historical periods which produce more creative people.
- (x) Is creativity essentially irrational? Why does it seem so mysterious?

These and some other questions encompass nearly all possible dimensions in this excellent book.

One would agree with the thesis that creativity is a complex objective as well as a subjective system. It is extremely difficult, if not impossible to explain. It must depend on the point of view of an individual and a social group and is necessarily multidimensional. The book, however, is rather tilted toward the western point of view and, therefore, lacks a global perspective. One author lists several individuals as the most creative people of this century — Einstein, Freud, Eliott, Stravinsky, Picasso, Martha Graham, and Gandhi. Obviously, there can be no unanimity on this.

Some statements in the book which are bold and perhaps offer some definitive answers are worth quoting.

Availability of certain measuring tools can mold the theories about what is to be measured and thus accepted group practices influence minds of group members. Ability to combine to seemingly unrelated ideas may be an important ingredient in creativity. Discovery involves a lengthy process of hard work and negotiation within a set of complex social networks. Scientific discoveries are not unique but multiple and also inevitable; if one person haven't thought of it — somebody else will certainly do.

What we count as creativity (or for that matter as 'intelligence') may depend on the methods we use to measure it. Creativity can be defined in terms of mapping, exploration, and transformation of structured conceptual spaces. Self-confidence, stubbornness and exceptionally hard work are often needed for new insight. Energy and commitment are essential and the creator expects very high standards of self and of others. Essentially, creativity is a puzzle, a paradox, and some say a mystery. There is a wide spread pattern

in inventions of combining something with its 'inverse' to form a single thing. The claw hammer joins the nail-driving mechanism with a nail-removal mechanism. The pencil with an eraser combines marking and unmarking functions.

Generally, the most pronounced breakthroughs come within a decade of the initial discovery. So an incubation period is a must. Support from other individuals is important. There can be masochistic side in creative individuals, e.g. extreme ascetism, self-centeredness, tendency to exploit others, sexual promiscuity, tireless litigation against others, and severity towards colleagues.

Creativity is not confined to scientists and artists. Clearly, intelligence is not a sufficient condition for great creativity but great achievers generally have high IQ levels. Somebody listed the following 13 traits that are commonly associated with creativity:

- (i) Independence in attitude and social behaviour,
- (ii) Dominance,
- (iii) Introversion,
- (iv) Openness to stimuli,
- (v) Wide interests,
- (vi) Self-acceptance,
- (vii) Infuitiveness,
- (viii) Flexibility,
- (ix) Social presence and poise,
- (x) An asocial attitude,
- (xi) Concern for social norms,
- (xii) Radicalism, and
- (xiii) Rejection of external constraints.

Thus, creativity gets linked not only with intelligence but also with motivation, personality, and social stimuli.

Creativity is often a threat to the great uncreative majority and hence severely penalized and suppressed.

The concluding lines of this book are: "Creativity lies at the cross-roads of intellect and personality; its understanding and measurement both rely on advances in these two fields and feed back results of empirical studies. It deserves greater attention that it has received".

Each chapter of this book, lists separately, numerous references and the reader can make use of these for further studies in the subject. There are a few sketches or diagrams in the book and many passages are long and heavy. Yet the subject matter is so absorbing that one can read on, though quite a few sections would require a second or third attempt for one to grasp all the ideas presented.

The reviewer recommends this book to all those who have themselves been concerned with questions about creativity earlier. They will get many more beautiful questions and a few beautiful answers.

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Reliability Engineering and Terotechnology, by A K Gupta (Macmillan India Ltd, New Delhi 110 002) 1996, pp 466, Price: Rs 225.00 [ISBN 0 333 92457 6]

Reliability Engineering and Terotechnology are not merely subjects of formalism, but a standard of the precision seeking competitive world. The book has seventeen chapters on the two topics with one exclusively on TQM and ISO 9000, which is much in vogue in the prevailing global economic scenario. Each chapter contains adequate number of examples with a list of review questions.

The first three chapters provide fundamentals for the beginners of the subject on topics such as basic definitions, variation, issues in reliability management, mathematical formulation of reliability, elementary probability theory with estimation and goodness-of-fit tests, failure/hazard rate with common distributions.

Reliability prediction as well as analysis is an on going process which is needed from designing through the complete life cycle. Chapter 4 provides various methods for reliability analysis such as Block-diagram method and Master equation method,. Various issues related to reliability design such as allocation, improvement, growth, along with Duane growth model are covered in chapter 5. Life testing, sequential testing, accelerated testing are covered in chapter 6 dealing with reliability testing. Maintainability and availability using MTTF, MTBF, MTTR, MDT are analysed in chapter 7 and chapter 8 gives a discussion on general project management issues. Chapter 9 and 10 are devoted to reliability computation, the technology based expert system approach, and software reliability.

Terotechnology as an integrated approach to resource or life-cycle management has now come of age since its inception in the 70s. It has many facets depending on the exact level of requirement in an organisation. For example, to understand maintenance, it may provide response through design, procurement, projects, operations, finance, and personnel. An overview in chapter 11 and its use in maintenance management (chapter 12) covers the subject lucidly. Signature analysis approach to condition based maintenance along with various methods comprises chapter 13. It also stresses on the use of microprocessor for increase in the level of precision but for the humane element involved in the process.

Quantitative analysis approach to maintenance resources using statistical and OR techniques such as LP, simulation, queues, replacement schemes and charting techniques comprises chapter 14 along with numerous examples. Management techniques contributing to productivity and effectiveness of the management department, behavioural science approach, costing and budgeting for maintenance are covered in brief in chapters 15 and 16.

Towards continued maintenance of world class quality, TQM and ISO 9000 series have become a hallmark for the industry. Chapter 17 describes the two aspects at some length. TQM is discussed through the phases of control, assurance, and total quality control. International standards on quality assurance known as ISO 9000 standards certification has become almost necessary for companies seeking to participate in global trade (For example, with European Union). This chapter also gives a description of the ISO 9000 series, quality audit.

On the whole, the reviewer feels the book fulfils the requirement of an undergraduate level professional course that does not call for extensive mathematical rigour.

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Knowledge, Innovation and Economy — An Evolutionary Exploration, by Witold Kwas'nicki (Edward Elgar, Brookfield, US) 1996, pp 240, Price: £ 45.00 (hb)

[ISBN 1 85898 349 5]

It is unfortunate that graduate level economics courses is still oblivious of different paradigms of economic

analysis. Generations of economics students are given over doses of Neo-classical economics, which is more of engineering than economics. The book under review is an excellent reading on non-neo-classical paradigms of economic analysis.

The book deals with industry level economics from the stand point of evolutionary economic ideas. In doing so, the Part I (divided into three sections) of the book provides a crisp discussion on basics of evolutionary economics and its distinction with neo-classical paradigm.

Not being able to come out of the Newtonian paradigm and its continuous effort to be fit into Newtonian physics have deprived Neo-classical economics from the post Newtonian development in the world of physics. As a result the neo-classical ideas and practices of economic analyses gradually drifted away from the reality with the turn of the century. The mathematical precision — the elegance of the neo-classical economic analysis, turned out to be its burden that has been the reason behind growing popularity of other approaches (new paradigms) in economic analysis over last half a century. Although even within neo-classical school there is recognition to the limitations of the conventional approach, acceptance of a new paradigm has been lukewarm. Reason appears to be that evolutionary economic analysis was yet to develop the elegance of neo-classical tools. Also, generations being trained in neo-classical premise of analysis scholars and researchers were probably uncomfortable with new premises of evolutionary explorations in economics.

The book serves the purpose of introducing scholars (not initiated in the tradition of evolutionary economics) to the basic theoretical foundations of the perspective and methodologies of evolutionary economics. The section 2 on "Knowledge Development As An Evolutionary Process" followed by section 3 on "Taxonomy of knowledge" in Part I of the book develops concepts of "Fulguration" (The act of creating something new) and "Epistechne" (a conjugation of knowledge and its application in human endeavor), through a lucid depiction of parallels between development of knowledge and the process of biological evolution. Central point is the development of individual knowledge. Breakthrough and revolutions (fulgurations) require to be understood, the author suggests, not only in terms of processes within the fields of science and technology but also in terms of cultural, social and

economic orders which play crucial role in individual personalities who created breakthrough.

With this backdrop the Part II of the book deals with neoclassical and evolutionary epistemes (instead of paradigms). The essential difference, the author suggests, "the neo-classical epitome is rooted in the Renaissance image of the world, and the evolutionary epitome is rooted in the 20th century image of the world" Neo-classical economists, however, could not shrug off the principles of classical physics (atomistic ontology and mechanistic metaphor) to embrace the new philosophical foundations of modern physics.

Limitations of neo-classical episteme are revealed in its dealing with the dynamic character of economic problems and also in its exploration of the role of technological change and innovation in economic process. Author reviews various neo-classical propositions and examines them in the light of an evolutionary model of industry development.

In contrast to the evolutionary approach of transition process neo-classical economics deals with equilibrium.

The Walrasian auctioneer has to have full knowledge required in the process of price setting. This indicates a system of centralized knowledge as opposed to the concept of liberal market system. In fact the neo-classical approach is not based on any theory of the process of knowledge development. The approach, instead, begins with an imaginary state of availability of complete and perfect knowledge.

Similarly, in neo-classical economics competition plays the role of gravitation in the Newtonian system. And competition is synonymous with price competition. The author draws attention to the fact that in reality there are various types of competitions for introduction of new products, new technologies, new modes of organisation of production, etc. In neo-classical economics, organisation is externally given. In reality, the author argues, organisations are adjusted and charged to the need arising out of the changes in the world.

Profit maximization is another commonly used assumption in the neo-classical approach. In the tradition of evolutionary school, more appropriate state is "search for profit" or "action motivated by profit". Similarly, a study of equilibrium as it is done in con-

ventional economics is uninteresting and far away from reality. What is, instead, pursued by evolutionary economics is the process of approaching equilibrium. Another serious distinction is regarding reversible time in neo-classical approach with asymmetric time of evolutionary approach.

Also, there is novelty in treatment of random factors in economic models; in decision making process and in the process of innovation. Thus it is treated no longer as the absence of complete information described by stochastic characteristics, instead, it is a trial and not process in evolutionary economics.

These premises are the basis of evolutionary model of either industry development or "self organisation model of industrial dynamics" — as author would like to call. The model author develops is for describing the behaviour of competing firms producing "functionally equivalent products".

Through computer simulation, the model has been used for economic analysis to address questions regarding price setting, long and short run objectives, concentration of industry, cost of production and productivity of capital, economies of scale, etc.

Simulation exercises are also carried out for developing a dynamic system. An excellent sub-section is on "Bounded rationality and fluctuations in Industry Development". In this section, instead of interest rate causing fluctuation in the system, the same has been examined by making firms computing ability limited.

A separate section is devoted to innovation and economic development. The author emphasises the importance of creative process in human mind (which is out of reach of any observation) over and above the quantitative information of R&D and patent. The central point is to capture the tacit knowledge available in a production system of a firm and develop a model on that basis. The model which, therefore, has been developed, following Nelson and Winter has "Routines" of a firm as focus. The set of routines employed by a firm evolves through mutation, recombination, transition and transposition. Research fund enables a firm discovering a new "routine". Considering innovation as groping in the dark, the author distinguishes among three innovation regimes in terms of cost of production, technical performance and productivity of capital. Simulations are done, therefore, to describe all these processes and also to examine already available hy-

pothesis available from several neo- classical studies and studies done in the tradition of evolutionary economics.

The merit of this book, however, lies as much in the effort to develop an elegant non-neo-classical approach to economies, as in the clear understanding of the limitations and weaknesses of evolutionary tradition. The author recognises the fact that evolutionary approach is still "far from being a coherent and complete theoretical system". The promise of the approach, as author would like to suggest, arises out of its roots in foundation of modern science.

The book is a must for the graduate students of economics, as well as researchers in the field of industry and innovation.

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Catalysing Cooperation: Design of Self-governing Organisations, by Tushaar Shah (Sage Publications, New Delhi) 1996, pp 315 +XV; Price: Rs 375/- (cloth); Rs 200/- (paper)
[ISBN 81 7036 5325 (India-h b); 81 7036 5333 (India-p b)]

At present, India is at a crisis point, as the old paradigms of development, governance and social organisation appear to be breaking down. Not a day passes without one more "scam" coming to light. The system of government has become dysfunctional in many of the states, especially in the Hindi belt. Social services are on the verge of collapse. The extensive system of public enterprises on which so much confidence was reposed has by-and- large turned unviable. The only hope now remains is that the program of economic reform, globalisation and liberalisation that we have embarked upon will bear fruits in short duration. This, however, presupposes that responsibility, efficiency, accountability, transparency, and above all, honesty can be rebuilt into the system. This means participatory democracy at all levels. The shareholder-owned but businesshouse- operated private corporations of India have a long way to go before they reach acceptable level of transparency, honesty and accountability. However, a fresh start, with enormous implications, is possible in another important sector of the old paradigm, namely, the self-governing cooperative sector.

The cooperative institutions were set up in the initial decades of independence in many areas, especially in the agricultural and food processing sector. This was because farmers were considered to need protection from the full rigors of the marketplace. The government played a fairly substantial role in almost all the cooperatives, setting up rules and procedures for operations, providing subsidies as well as favourable market access. At the same time, it also took responsibility for their administration by insisting on membership in their governing bodies. The results over the years have not been very impressive. Apart from the examples of Amul and a few sugar cooperatives in Maharashtra, it is hard to point out to cooperatives which have competed and grown in the economy, at the same time protecting their members' interests. All too often, the cooperatives have only provided another venue for the aggrandisement of politicians, and for the "milking" off of public funds into private pockets. The reasons for this have more to do with the way the cooperatives operate, and the environment in which they are constrained to operate than in any special corruption, or inefficiency of the cooperative operatives as compared with the rest of society. Cooperatives take on some of the characteristics of public goods, in non- excludability and joint consumption. It is difficult to exclude "free riders" and to ensure that the benefits are restricted to the members. Hence the system breaks down in a short time. Only in cases when the cooperative was under the control of an exceptionally well talented and determined individual has it been able to survive.

The need for the cooperative sector remains as high as ever. But the way the cooperatives operate has to be changed so as to enable them to survive and protect the interests of the members. This has to be done by the masses, and the need for exceptional leadership should not be there. Pious statements about removing political interference will not do; the cooperative has to be designed to withstand pressures. This book is about the design of cooperatives and farmers organisations that can survive and grow in the rough and tumble of the marketplace and withstand pressures. It suggests that successful cooperatives and farmers organisations differ from the rest in their capacity to preserve their interests, innovate and to propagate across regions and cultures. It tries to identify the "genes" for success in such organisations by setting up many comparative investigations of both successful and unsuccessful

cases: the successful water cooperatives and sugar cooperatives in Gujarat and Maharashtra, the highly successful Anand pattern, etc. versus the failure of similar attempts in other states such as UP and Bihar.

It has been suggested that the success of cooperatives in some areas of the country versus relative failure in others has more to do with the cultural make up of the region rather than any other factor. Shah dispels this notion by pointing to failures of the cooperatives in several areas such as chicory and tobacco in the Kheda area of Gujarat, the same area that gave birth to the successful Anand pattern. By examining successes and failures of cooperatives from the same area, run by the same type of people, Shah accomplishes something that is relatively rare in the social sciences: an opportunity to do an experiment with "controls" and test cases. He suggests that while efficiency, leadership, etc. are important, success in fact is critically dependent on the design of the organisation. He offers a colourful analogy: if the design of a ship is faulty, no amount of skill on the part of the captain or navigator can make it sail efficiently. The design features that make up the difference between success and failure are analysed extensively in the book. They can be briefly summarised as follows:

(i) The organisation should have a purpose which is central to the concern of the members, and benefitting them directly. It should also be possible to exclude non-members from sharing of at least the direct benefits.

(ii) There should be patronage cohesiveness: i.e., the managers or governors of the cooperative should have an immediate and many benefit from the purposes of the cooperative, and they should, as far as possible, have no other competing interests. The personal fortunes of the members of the board should be dependent on the efficient performance of the cooperative, and on its services to the members.

(iii) Governance effectiveness to be secured by laying down clear rules and operating procedures, but simplified as much as possible, and accountability and transparency ensured by rights of recall. The CEO is appointed by and answerable to the governing board.

(iv) Operational efficiency to be ensured by performance-linked rewards. Continual efforts may be made to secure and retain membership loyalty.

Analysis of the failures indicates that one or more of these design features have been violated. Politicians or governmental administrators do not have the cooperative as their major source of income, and in any case their income is not linked to the benefits provided to the members; cooperatives are often started by governmental initiative to satisfy some socially perceived needs, which are not identical to the needs of the members. Also it should be remembered that cooperatives operate in the marketplace, offering services that are already being offered by private agencies, however exploitatively. Only when the cooperative is able to offer an overall better package of services it is likely to succeed. For example, traditional moneylenders offer easier access, lesser guarantees, flexible terms, possibility of repayment in kind, etc. which somewhat compensate for the higher interest rates; it is not expected that a cooperative society or bank will be able to compete with them simply on the basis of interest rates alone. In volatile, dynamic markets such as cotton and oilseeds, the traditional operators are able to respond faster to market changes, and their skills and acumen is not easily achieved by the less experienced cooperative managers. Traditional operators also have extraordinary resilience, ability to survive on smaller margins, and often an extensive and informal credit and patronage network. Investor owned organisations of the modern corporate types, also competing in the same area, have at least three distinct advantages over the cooperative system: (i) they are able to mobilise large volumes of capital at relatively lower costs; (ii) their design permits effective transmission of the goals of the management to the operating levels, and (iii) the institution of the share market offers a means, however imperfect, for the owners to constantly monitor the performance of the governance structure as well as the operating systems, and to opt out when needed. In direct competition with private corporations or traditional operators, cooperatives have difficulties in succeeding, unless their system is geared up for the single minded pursuit of the member's patronage interests. High level social agendas will not do; an honest, clear cut and noble governing board is useless if it uses the surplus of the cooperative for general do-goodiness. The cooperative will succeed only if the surplus or profits are used so as to further increase the capacity and interests of the members to increase their business with the cooperative. Where the cooperative, especially farmers organisations have an advantage in the area of stable supplier relationships, when the process-

ing factory is owned by the members who themselves are the suppliers. This has been the case in the successful examples of dairy cooperatives as well as the successful sugar cooperatives of Maharashtra.

The book is organized in three parts, the first section lays the groundwork and general principles, it also examines some cases of successes and failures. The second section provides examples in three successful areas: water management, sugar cooperatives, and the Anand pattern. In the third section, the lessons from the examples, both successes and failures, are brought together in an overall synthesis, arrive at general design principles. The last chapter makes practical sugges-

tions for improving the performance of cooperatives in several specific applications.

At the time when the nation as a whole is looking for better and more effective ways of self-governance, Tushaar Shah's book is of considerable interest in providing a possible blueprint for the design of successful self-governing organisations. His book will be of significance to all those interested in creating successful participatory organizations and governing systems, and not only to planners or cooperative managers.

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SCI-TECH UPDATE

Internet services through wireless communication

Internet access is provided by service providers ranging from a comparatively less costly telephone wires using powerful modems or through leased lines for those who can spend more money or through still more costly and sophisticated VSAT technology that eliminate the problems encountered in terrestrial communication.

Metricom, a California-based Internet Service Provider (ISP) offers a solution to access to Internet in which no wired connections are necessary using their expanding radio network. The company is offering this service via system of shoebar-size radios spaced at half-a-mile intervals and mounted atop utility poles. Users access this local-packet radio network via Metricom's external R-cohet radio modem.

Metricom maintains a frame-relay network. The Metricom network connects to the wired world via Wired Access Points (WAP) which receive 1 k packets from the pole-top radios and pass them to their frame-relay network. The company is about to install a nation-wide frame-relay backbone.

The Ricochet modem communicates with Metricom's network via a standard TCP/IP link. This enables the users to use any TCP/IP software including the Windows 95 stack and Web browsers like MS Explorer and Netscape Navigator.

The main drawback in Metricom's system is its technology requires to be installed on a locality-by-locality basis. Thus to provide greater coverage permission from local authorities in each region is required. So far the entire San Francisco Bay has been wired and the company hopes to cover all of major U.S. cities in about 2 or 3 years. The network is in use at Microsoft's Redmond headquarters.

The Ricochet modem costs about \$299 to buy or \$10 per month to rent in addition to Metricom's ISP charges. [*PC Mag, India*, 3 (9) 12].

□

DSRM

Measuring up to the science of accuracy

British engineers have developed unique and accurate measurement systems that give manufacturers the ability to machine components to new levels of precision and to take measurements traceable to the international standard — the wavelength of light. This drive to achieve much improved quality and reliability in manufactured goods has been fostered by increasingly intense global competition.

Renishaw plc, the world's leading specialists in metrology — the science of measurements, have designed a probe for checking the dimensions of a car cylinder block which is one of a wide range of equipment pioneered by it.

Renishaw's patented touch-trigger probes are fitted to computer numerically controlled machine tools in thousands of manufacturing bases worldwide, wherever high-quality measurement is needed in industry. They allow fast and repeatable readings to be taken automatically during the manufacturing operation, updating the machine's operating parameters as its working progresses.

These probes must be robust enough to withstand the hostile metal-cutting environment of hot-metal chips and high-pressure coolant. Its latest versions, using micro strain-gauge technology, can be used on coordinate-measuring machines to check finished components with repeatable accuracy down to one-third of a micron.

The technology being applied by Renishaw to designing and developing its products has created uniquely capable equipment. One is an in-house inspection device that can measure to within one nanometer (one-millionth of a micron).

Another is a revolutionary system that provides automated milling, turning and inspection on a vertical machining centre with automated loading and unloading of raw materials, tools and machine components — all without manual intervention.

Renishaw's exports reached a record level of £57.3 million in 1995, more than 95% of the company's total sales [*Spectrum*, No.254 (1996) p.21]. □

HKK

Remote scanning by cheap micromirror

Ultra-light zoom lenses, space telescopes that can change focus from Earth, and bar code scanners that can read labels from any distance are all among the developments promised by a microchip device developed at Delft University of Technology in the Netherlands.

Researchers at the Delft Institute of Microelectronics and Submicron Technology (DIMES) have come up with a chip carrying a single mirror that can change shape almost instantaneously. The mirror is formed from a thin silicon nitride film a couple of millimeters square and 0.7 micrometers thick—one-hundredth the thickness of a human hair. This is coated with a reflective layer of aluminium and framed in silicon, like a painting.

The framed mirror is mounted on a microchip that carries one or more electrodes. A charge applied to a single electrode pulls the reflective film down into a paraboloid—the shape of miniature satellite dish. The focal length of the mirror can be changed simply by changing the voltage on the electrode.

It means one can zoom without heavy lenses and moving parts, said Simon Middelhoek, the project leader. This can be useful for cameras, and for equipment such as bar code scanners. These normally have a mirror with a fixed focal length, which means that bar codes have to be fixed a distance from the scanner to be read. The adjustable mirror could make life easier in warehouses and shops.

According to Middelhoek, the main appeal lies in the mirror's ability to react rapidly, and this could make it useful in ground-based telescopes. With multiple electrodes the mirror can be deformed fast enough to follow the image of a star as atmospheric turbulence makes it appear to wiggle in the sky. The complex electromechanical systems that now do this cost £ 100 000 or more. This device is going to be much cheaper, thanks to microchip technology, make adaptive optics affordable, even for amateur astronomers.

Astronomers might one day be able to change the optics in a space telescope by transmitting new soft-

ware, instead of sending up astronauts to install new optics by hand.

The Delft scientists see projection television as another application. By mounting the nitride film on a rigid grid, they hope to form an array of independently controllable mirrors, each one controlling the light that projects a single pixel onto a screen. Together will be universities of Neuchatel in Switzerland and Edinburgh in Scotland they are now working on a chip 16 pixels square [*New Sci*, 151 (2039) (1996) 20]. □

Automated robotic sensor for avoiding collisions

A leading automation firm in Manchester, UK Robotics Ltd had developed a novel robotic sensor that automatically detect and avoid objects heading for collisions. Basically the device is a robotic manipulator for collision avoiding, it has applications in a variety of situations, particularly in hazardous environments such as in the construction industry and inside nuclear installations.

Robotic manipulators are becoming an increasingly important tool in areas where conventional programmed robots cannot operate. Under these conditions, each task can have unique characteristics, with many tasks not anticipated prior to starting work.

The sensor system comprises three main components: the sensor plates the manipulator/robot mounted electronic module, and a computer interface.

Sensor plates are either embedded in epoxy for protection or, in applications of complex geometry, they can be mental-sprayed onto a moulded surface and become a fixture of the manipulator. Software for the system runs on a standard PC, giving both audible and visual feedback to the operator. The principle of the operation is straightforward. A metal plate's capacitance to earth is altered by the proximity of any earthed conductive object such as steel, aluminum or reinforced concrete.

When this happens, the resulting signal, influenced by nearby objects, is filtered and amplified before passing to the digital controller. [*Spectrum* (Brit Sci Newslett) No. 254, Sept/Oct 1996, 2]. □

RS

Ultrasensitive biosensors developed

A novel form of atomic force microscopy (AFM) has been adapted by Dr Richard Cotton, a biophysicist

and others at the Naval Research Lab, near Washington (USA). The new sensor is at least 100 times more sensitive and of better resolution than traditional NDT type ultrasonic biosensors. Furthermore, the device is compact, rugged and portable.

In the new device, the cantilever of AFM is coated with antibodies able to bind to the specific antigen (cell, protein, virus or bacteria) being sought. Next, a solution containing the antigen flows over the cantilever, and some of the antigen binds to the antibodies. Then another solution, containing antibody-coated, micron-sized magnetic beads, flows by, and some beads bind to the antigen on the cantilever. Finally, a magnetic field is turned on and the captured beads are counted by the deflection of the cantilever. In this way, antigen concentrations down to attomolar (10^{-18} M) levels can be measured. In a working device, an array of these biosensors would be able to perform such immunoassays in about 10 minutes, much faster than other methods at these small concentrations [*Phys Update* (AIP, Oregon, USA), No. 265 (1996) 1]. □

RS

Design for new reusable spacecraft unveiled

Lockheed Martin Corporation, Palmdale, California will design a new reusable spaceship for NASA operations called X-33 that will take off vertically like a rocket and land horizontally like an airplane and eventually haul payloads into space at one-tenth the cost of the space shuttle.

It is expected to replace the space shuttle and help put more people in space for less money. The test model resembles a flat wedge or triangle without wings. Unlike the shuttle, it is designed to fly without dropping off disposable parts such as fuel tanks and booster rockets. It also will feature more efficient engines, lighter fuel tanks and more durable thermal insulation.

The new spacecraft would operate similar to an airliner that is capable of flying every few days—40 to 50 times a year—instead of only flying seven or eight times a year like the shuttle. A full-scale version of the X-33 is expected to become operational in 2006 or 2007, just about the time the shuttle is due to be phased out.

Under the terms of the new agreement signed with NASA, Lockheed Martin will develop the experimen-

tal X-33 and conduct at least 15 suborbital test flights in 1999. The test vehicle will be about 20 meters tall and 20 meters wide, will be remotely piloted and capable of reaching altitudes up to 80 km.

Once the flight test evaluations are complete overcoming some technical hurdles, development of a reusable launch vehicle called "VentureStar", which would be twice as large as the X-33 test vehicle may be considered.

The goal of the new vessel is to lower the cost of launching cargo into orbit through the use of tougher, lighter materials in the airframe, propellant tanks and outer surfaces of the spacecraft [*Sci Update*, July 1996, pp 11-12]. □

DSRM

Rotary displacement sensor saves space

Researchers at the Lucas SchaevitzTM have made a device which is first in a series of flat, non-contact rotary displacement sensors which eliminates wipers, brushes, slip rings, and magnetic materials. Called the RVIT-Z, the new sensor combines proprietary Rotary Variable Inductive Transformer technology and signal conditioning circuitry on a single PC board.

The RVIT-Z currently provides the lowest profile, high-accuracy, high-reliability rotary sensor on the market. Smaller, flatter, and lighter in weight than conventional rotary sensors, the RVIT-Z offers absolute position measurement over 0 to 120° (± 60), as well as guaranteed performance over an extended operating temperature range of -40 to +125°C. Typical output options include +0.5 Vdc to +4.5 Vdc, ± 2.5 Vdc, and ± 10 Vdc, with suggested input voltages of +5 Vdc, +12 Vdc, or ± 15 Vdc. Factory calibration and automated testing assures a nonlinearity error of less than $\pm 0.5\%$.

As the modular design of the RVIT-Z provides a high degree of flexibility, hence the rotary sensor is easily integrated into new or existing designs. It is claimed that the RVIT-Z can also be tailored for remote sensing or board-level integration, allowing the rotary sensing element to remain isolated from the autoplex measurement circuitry.

Applications include pedal or throttle positioning, valve flow control system, and robotics [*Des News*, 51 (13) (1996) p. 92]. □

HKK

Improved technologies for cost reduction in offshore operations

To achieve offshore cost reductions of 30-50 per cent, Norsok project concentrates on cost cutting and working relations, bringing in technology improvements. Following are some of the challenging areas that Det Norske Veritas (DNV), Norway is envisaging to meet in near future.

Residual capacity of corroded pipelines

Cost reduction can be achieved either by higher utilisation or by increasing the design life for the pipelines. This may be done by re-evaluating the capacity of the corroded pipeline and prove maintained acceptable level of safety: Great caution must be shown when updating old rules or criteria.

A corroded pipeline has, traditionally, a capacity expressed in terms of internal pressure only but axial loads or moments should also be considered. This has not been critical earlier due to the implicit conservatism in the rules; however, applying new research where utilisation has increased, this may no longer be acceptable.

DNA has initiated a study where, influence of moment on the corroded pipeline or riser's internal pressure capacity is studied. This is accompanied by a calibration of safety factors based on reliability analysis.

The project will take advantage of previous experience of internal pressure capacity calculations from earlier work. The influence of moments on the internal pressure capacity has already been assessed on a case-to-case basis for some risers and that will also be taken into account.

Assessing the behaviour of sand

Unprocessed hydrocarbons are transported in pipelines from subsea templates to a neighbouring processing platforms. Sometimes the sand contained by hydrocarbons may settle in the subsea pipeline blocking by the pipeline and increases the corrosion attacks reducing the efficiency of corrosion inhibitors beneath a permanent sea bed.

A new medium-pressure multi-phase (oil-water-gas-sand-chemical) test rig has been built in DNV's process laboratory at Hovik. The test rig is designed with special emphasis on the investigation of condi-

tions for sand settling and sand entrainment in multiphase pipelines, as well as to investigate the effect of inhibitors and other chemicals on sand setting and on corrosion attacks in the pipelines. A major experimental programme is ongoing, where effects of sand particle size, gas-liquid-ratio, water cut, pressure and chemicals will be examined. These results will be used as a basis for verification and development of prediction models, and to gain general insight into the characteristics of sand settlement and performance of inhibitors and chemicals in multiphase pipelines.

Deep-water technology challenges

As a response to the new challenges in deeper water on the Norwegian continental shelf, such as Voring and More Basin, DNV has launched several new projects in cooperation with Norwegian Research Council, oil companies and technology partners such as Marintek, Sintef, Seaflex and others.

A project on Design Procedures and Acceptance Criteria for Deep Water Risers addresses the challenges of new riser designs and new materials, and will supplement existing riser design codes. Another project dealing with deep water analysis tools attempts to develop enhanced capabilities for prediction of design responses for floater/mooring and riser systems, taking into account interaction effects. Existing tools for simulation of the response behaviour of offshore structures will be improved to cover in a more realistic way important effects such as ringing, vortex shedding and slowly varying motions, as well as interaction effects between floaters, moorings and riser systems.

Riser technology

Under Norsk Hydro's direction, a novel riser concept for the large-scale use of titanium for structural purposes is being studied through individual, flexible titanium pipe risers. Oil will flow from 27 sub-sea wells at 335 meters depth to a catenary-anchored floating production unit.

So far, titanium has shown excellent resistance to corrosion for temperatures up to 90°C, but Visund will produce oil and gas at temperatures up to 115°C. To obtain good resistance to corrosion, Grade 23 titanium containing additions of palladium or ruthenium is adopted. In DNV's corrosion lab near Bergen nearly one hundred test specimens are subjected to crevice and pitting corrosion tests, sulphide stress corrosion

testing and slow strain rate testing in order to verify the expected good corrosion resistance at 115°C.

Fatigue crack growth measurements in air and 110°C sea-water, and fracture toughness testing are also carried out at DNV'S laboratory at Hovik to provide the necessary materials characteristics for fracture mechanics assessments of weld defects. [DNV Forum, Hovik, Norway, No. 2, 1996, 17-20]. □

DSRM

Slide for a dental laser

Hepco Slide System Ltd., Devon, UK have reported development of a linear slide to the portable dental laser to guide and retract the systems's hand-held tool.

The OralMedicTM from MLT Ltd., is a CO₂-based dental system for treating soft tissues. It generates a 10.6 micron wavelength to excise tissue for treating gingivitis or conducting other minor oral surgery. The laser cuts and heals the wounds immediately thus reducing blood loss and speeding up the process of recovery.

The dental system's portable base unit houses the laser, a mirror for directing the beam, and controls. The dentist removes the retractable hand-held tool which delivers the laser through a fibre-optic cable. The Hepco's Generation II linear slide is added to the system to make it compact and less expensive. The slide system guides the hand-held tool on a precision-ground slideway and aluminium carriage plate. The slide rides on two concentric journals for system adjustment.

The Generation II gives engineers the option to specify a variety of components as a preassembled, off-the shelf, ready-to-install unit. Three sizes of cap seals add the ability to seal, wipe, and lubricate the linear slide.

Further information can be obtained from Hepco Slide Systems Ltd [Des. News, 51 (12) (1996) 49]. □

DSRM

Full spectrum lit school students perform better

A recent research project has conducted an interesting study in Alberta, Canada of the impact of full-spectrum light on the student performance and health in school. The most striking conclusions of this study were:

- 1 The students in full spectrum light were healthier and attended school 3.2 to 3.8 days more per year;
- 2 Libraries with superior light resulted in significantly lower levels;
- 3 Full-spectrum lighting induced more positive moods in students; and
- 4 Because of additional vitamin D received by the students in full spectrum light, they had 9 times less dental decay and grew in height an average of 2.1 cm more (over the two year period) than students attending school with average light.

Subsequently, prompted by this project, Innovative Design Inc., North Carolina, USA has attempted to investigate the performance of students in three daylit schools. Four Oaks, Clayton and Selma designed by the firm in North Carolina. The objectives of the investigation were to review:

- 1 Improvement in performance within each school from year to year;
- 2 Relative improvement in performance between Innovative Design's three daylit schools and the improvement in the Country-wide average for similar grade levels;
- 3 First year student performance at a fourth daylit school; and
- 4 Relative improvement in performance of a new, non-daylit middle school constructed in the County during the same time frame.

Although there are many variables that can alter student performance, it appears that the students attending daylit schools clearly benefit by being in the superior, daylit learning environments. The main conclusions of the study are:

- 1 The students who attended daylit schools outperformed the students who were attending non-daylit schools by 5-14%. Considering the impact on student performance resulting from being within a daylit facility for a number of years, the impact is even greater. During the same time-frame, Clayton's 8th graders showed a 21% improvement of 10%. The Selma Middle school 7th graders showed a 32% gain versus the norm of 15%. This equates to an average increase of 14% better performance by the students in daylit schools.

- 2 "New" does not necessarily translate into better performance. The new, non-daylit North Johnston Middle School actually showed a negative impact on the student's performance.
- 3 It is quite clear that placing students in temporary, mobile classroom units had a very significant and negative impact on the performance of the students.

For further information, contact: Innovative Design Inc., 850 West Morgan Street, Raleigh, North Carolina, 27603, USA [*Sun Wrld*, 20 (3) (1996) 13-14]. □

DSRM

Techniques for recycling chiral catalysts

Researches have developed two new techniques that facilitate the recovery of expensive chiral catalysts used in asymmetric synthesis.

In one method, chiral reagents are linked to a soluble polymer that can be precipitated easily from solution, making it possible to isolate and recycle the reagents. In the other strategy, chiral catalysts are immobilized in membranes that can be regenerated and reused.

The first technique has been demonstrated on chiral catalysts for the asymmetric dihydroxylation reaction - one of the most frequently referenced reactions in organic chemistry. That procedure was developed in 1988 by chemistry Professor K Barry Sharpless' group. Sharpless was then at Massachusetts Institute of Technology and is now at Scripps Research Institute, La Jolla, Calif.

The catalysts are complexes of osmium tetroxide and one of several asymmetric cinchona alkaloid ligands (derivatives of hydroquinine and hydroquinidine), which are expensive. The cost of these ligands can be especially high when the reaction is used for large-scale bulk syntheses. What one likes to be able to do is to recover the chiral ligands, if possible.

Various groups, including that of Sharpless and co-workers, have tried attaching the ligands to insoluble polymer supports to facilitate their recovery, but this strategy has never worked very well. When ligands are bound to an insoluble polymer, reaction yields are low, enantioselectivities are poor, and reaction times are inordinately long compared with the use of free ligands in solution.

Putting a ligand on an insoluble polymer is like isolating it. It is like having ligand, metal, and substrate in solution. They all can interact with each other equally; they all have a chance to work in concert. But if one takes the ligand out and puts it behind a door that only opens at certain times, then it doesn't have an equal chance. That's a major problem with insoluble supports.

In an effort to avoid this problem, Janda and senior research associate Hyunsoo Han synthesized cinchona alkaloid ligands chemically linked to the soluble polymer polyethylene glycolmonomethyl ether (MeO-PEG). They found the polymer-bound ligands could be used successfully to dihydroxylate various olefins [*J Am Chem Soc*, 118, (1996) 7632].

When they immobilize the ligands on the soluble polymer, the reaction time is the same as it would be in solution, the yields are the same, the ee's [enantiomeric excesses] are the same, and one can recover them at the end. The researchers have achieved ligand recoveries exceeding 98 per cent.

According to Janda and Han: MeO-PEG polymer will not only be useful to the research chemist but also for effecting the separation of catalyst from product in homogeneous [solution-phase] industrial applications. Finally, because of its desirable physical properties, this and other ligand-accelerated catalysts that are incorporated within liquid phase supports may find use in automated high throughput synthetic efforts."

A second catalyst-recovery strategy-developed by Ivo F J Vankelecom and coworkers at the Center for Surface Chemistry & Catalysis at Catholic University of Louvain, Belgium — involves the immobilization of chiral catalysts in elastomeric polydimethylsiloxane membranes [*Angew Chem Int Ed Engl*, 35 (1996) 1346]. The technique was demonstrated on two catalysts: a ruthenium-binaphthyl complex (Ru-BINAP) used in asymmetric hydrogenations, and a manganese-based "salen" catalyst discovered by Jacobsen and coworkers and used in asymmetric epoxidation reactions.

Both catalysts have been used for laboratory-scale and industrial syntheses- by Merck & Co., for example. But recycling the catalysts previously has not been possible, except for a three-phase technique for Ru-BINAP reported in 1994 by Kam T.Wan and Mark E. Davis of the division of chemistry and chemical engi-

neering at California Institute of Technology [*Nature*, 370,449(1994)]. In this technique, a thin film of the metal complex is retained on a support, where it exhibits long-term stability and "behaves like a homogeneous catalyst with high activity and enantioselectivity," according to Wan Jacobsen commented "in general it is very helpful to be able to remove and recycle catalysts easily and that is often hard with simple homogeneous systems." Vankelecom and coworkers were able to achieve recycling of the Ru-BNAP and Jacobsen catalysts by immobilizing them in polydimethylsiloxane membranes. In both cases this resulted in 'a perfectly regenerable catalytically active membrane....that provided essentially the same catalytic activity, product and enantiomeric selectivity as [in]the homogeneous case," according to the researchers.

They point out that the catalyst is not linked covalently to the membrane, which would end to impair its catalytic activity and enantioselectivity. Instead, it is maintained passively in the elastomer's hydrophobic environment because the membrane's pores are too small to permit it to escape.

The technique is appealing in that membrane immobilization does not require covalent modification of the ligand. The catalyst is essentially identical to the catalysts in solution, except that it is trapped inside a lipophilic membrane. Janda and Han's soluble-polymer approach, on the other hand, entails covalent modification of the catalyst in attaching it to the MeO-PEG polymer explained. The membrane-immobilization technique will be applicable to other types of chiral catalysts and to large-scale industrial syntheses [*Chem Eng News*, 74 (35) (1996) 35]. □

Display polymer

German company Hoechst is developing a new light-emitting polymer using a low voltage for the display and electronic industry. Applications for the new polymer range from simple backlight to complex display signs. Specialists at Hoechst claim that by the year 2000 — when the company anticipates commercial start-up — the display market will be worth as much as \$40bn/year.

'The devices are thin and can potentially be manufactured using flexible substrates, they are building up this technology as a display technology. They are starting with a customised approach and are working on backlighting where one can build on the flatness of the

technology. It will start at the low technology end but it has the potential to go to the high technology end in electronics.'

Hoechst is also looking at more innovative uses. There are classic areas, in electronics and sign applications and there are more markets.

In order to bridge the high technology end of the project Hoechst has agreed a joint venture partnership with multinational technology company Philips. The technology was first developed in Cambridge University, UK, in 1989, and began to be developed by Hoechst 18 months later. To date Hoechst's R&D costs for the project have totalled less than \$10m. Pilot-scale production of the light-emitting polymer has started in Corpus Christi, Texas. The location of a production-scale plant could be in Japan, although this has yet to be decided. There is no doubt that this product will be in the Japanese, European and US market. There are no details of the scale of production, with both the technology and the market uses, revenue and market share it is unclear, added Schenk.

It fits well in their overall product portfolio — they are looking for high-margin product that adds a different category of value to the company — such as with micro-electronics [*Eur Chem News*, 66 (1733) (1996) 49]. □

Improved acid catalyst

Degussa has developed a new type of solid acid catalyst, which the company claims is more advanced than traditional polystyrene-based catalysts by offering high selectivity and extended lifetime.

The company's Deloxan catalysts are organofunctional polysiloxanes designed to resist higher temperatures, provide stability against shrinking and swelling in organic media, and increase pore volume by a factor of two compared to traditional materials.

Degussa is offering the catalyst as both micropheres for suspension processes and as spheres with diameters up to 1.4mm for fixed bed catalysis.

The catalysts can be used in a wide variety of acid catalysed reactions; for example, in the synthesis of di-octylphthalate, alkylphenols, organic acetates, as well as in free fatty acid esterification. The catalysts can be retrofitted to existing systems, providing

cheaper processes with reduced environment impact [*Eur Chem News*, **66** (1733) (1996) 49]. □

Ironing out industry's wastes

Molten iron could be used to recycle everything from toxic industrial waste to beer cans, according to American researchers. Their proto type system can convert waste into reusable products, with no poisonous by-products.

Christopher Nagel and his team at Molten Metal Technology in Waltham, Massachusetts, working with Robert Bach, a chemist at Wayne State University in Detroit, Michigan, use the power of molten iron at 750°C to tear apart waste into its constituent elements. The iron then acts as a catalyst, combining the elements to produce useful gases, metal alloys and ceramics.

Recycling highly toxic industrial effluents—for example, the toluene diisocyanate solutions from the manufacture of polyurethane—is usually not cost-effective. But incineration can release nitrogen and sulphur oxides, which cause acid rain, and even generate poisons such as dioxins.

Nagel and his colleagues realised that breaking up the waste into its component atoms and then allowing them to form stable products was the key to getting rid of waste without by-products.

The researchers have demonstrated their recycling system on several industrial waste streams in a pilot plant in Massachusetts. They found that the solvent chlorobenzene contaminated with cobalt oxide—a common waste product of chlorinated compound manufacture—was broken down by molten iron into hydrogen, carbon, chlorine, oxygen and cobalt atoms.

In the latest issue of *Environmental Science and Technology* (vol 30, p 2155), the researchers explain that by adding certain chemicals, such as hydrogen, and varying the operating conditions they were able to switch reaction paths and end up with different products.

In the case of the chlorobenzene and cobalt oxide mixture, the main product is synthesis gas, a mixture of mainly carbon monoxide and hydrogen that can be recycled as a chemical feedstock. Chlorine is recovered as hydrogen chloride gas. The process also produces an iron-cobalt alloy, which can be used for making steel.

The system is not limited to chemical waste. The team has successfully converted mixed metal and plastic waste from missile guidance systems into synthesis gas and iron alloys.

The researchers have patented the technology. It produces levels of nitrogen and sulphur oxides below the detection limits of between 1 and 100 parts per million, while achieving removal efficiencies of over 99.9999 per cent [*New Sci*, **151** (2039) (1996) 23]. □

RS

X-ray lithography system developed

In a novel X-ray lithographic system developed by a team of electronic engineers under Dr Henry Smith of Massachusetts Institute of Technology, Cambridge (USA) it is possible to design components as small as 25nm, which is much more finer than the conventional silicon chip technology. Furthermore, the MIT technology is more flexible than conventional ones by permitting chips to be customized easily. This is because the new technology dispenses the traditional fixed-pattern masks (stencils) through which light passes to etch patterns on the Si-wafer. Again the system, eliminates the risk of damage to chips in usual optical lithography, ordaining the mask to be placed very close to the wafer.

In the new MIT technique the X-rays are focused onto the silicon wafer through a computer-controlled array of hundreds of tiny mechanised windows. Each window has two components. The upper part is a lens to focus the X-ray, and the lower part is a micro-mechanical shutter to turn parts of the beam on and off during scanning.

The flat lens, known as a zone plate, is similar to a Fresnel lens. It is patterned with a series of transparent and opaque rings that focus the beam. By choosing the right X-ray source and designing the zone plates correctly, it is feasible to focus the X-rays into a spot of about 25nm. Each focussed section of the beam can be switched on or off by Si-wafer microshutter.

Several hundreds of such shutters ('windows') form 10-100m square array. Given that the area to be etched is hundreds or thousand times the size of focused spot on the silicon, the whole array must be scanned back and forth in order to fill in the entire area. Using existing X-ray sensitive materials, Smith calculates that a wafer could be written at a rate of 1 square

centimetre per second, practically same as that of existing optical means. However, the computer-controlled switches in the new system allow each new circuit to be different without the need for new masks, while the higher resolution of X-rays allows each square centimetre of chip to be much more complex.

The only part of the MIT scheme that may require new technology stems from the proposed use of uranium to absorb X-rays in the zone plates. Gold rings on the zone plates would only allow 10 per cent of the X-rays to be used for patterning. But spent uranium improves the efficiency to 31 per cent. The main problem with uranium films is that they can easily catch fire in hot air, but by adapting techniques vogue in nuclear labs this can be easily controlled.

The MIT and currently vogue similar technologies available in Japan and in Taiwan [for an excellent review of X-ray lithography systems the reader is referred to the article of Dz-chi Li, *JSIR*, Oct 1994, 749-67] are extensively investigated upon for commercial exploitation with a view to miniaturize silicon and other semiconductor structures [*New Sci*, 152 (No. 2050) (1996) 17].

□

RS

Biopackaging material

An environment-friendly viable alternative to plastics has been developed and commercially exploited by an Austrian firm, BIOPAC at Tribuswinkel which relies purely on biological materials. Unlike plastics, the new packaging material can be easily pulped and composted. So convenient, this material as packaging was used at the 1994 Winter Olympics at Lillehammer in Germany.

The range of compostable Biopac dry packaging which is made mainly of starch, includes trays and plates for fruit, vegetables, bakery products, confectionery, snacks and bread-rolls as well as ampoules and a variety of technical packaging products. Cups and other BIOPAC containers will soon be available for drinks and hamburgers [*Aust S&T Trade News* (New Delhi -110 019), No 67 (3) 1996, 3].

□

RS

Pulsed ultrahigh energy lasers at Livermore

It is customary to rate very high energy power pulsed lasers in advanced labs to a few tens of gigawatts (10^9 W) which is still a million times weaker than the

power/output of sun through D-T fusion! But quite recently a team of researchers under Prof Michael Perry at the renowned Lawrence Livermore National Laboratory in California (USA) have just put forward the petawatt (10^{15} W) threshold pulsed laser. The 1.3 petawatt burst was 1300 times as powerful as the entire US electricity generating system, though it lasted less than half a picosecond. The key to achieving that record power is an ingenious technique that stretches extremely short laser pulses, amplifies them, then recompresses them to concentrate their power into tiny interval.

Lasers are very good at concentrating bursts of energy into very short pulses. At a constant energy, the shorter the pulse, the higher the peak power. So a laser that delivers a joule of energy in a nanosecond has a peak power of a gigawatt. But potential damage to laser materials normally puts an upper limit on peak power.

After sustained investigations during the past 3 years, the Livermore group could overcome this limit using a technique called chirped pulse amplification. They start with a low-power pulse lasting just 0.1 picosecond. Because of the uncertainty principle, any pulse so short is spread over a range of wavelengths. To begin with, in the Livermore technique, a diffraction grating spreads out the wavelengths, sending them along different optical paths and stretching the pulse to 3 nanoseconds. This reduces the peak power so that a series of laser modules - including one arm of the lab's Nova laser, built for fusion experiments - can amplify it to high energy without damaging the laser glass. Then another diffraction grating squeezes the pulse down to less than half a picosecond, increasing its peak power nearly 10000 times to 1.3 petawatts.

The Laboratory plans to use the system in experiments in use the system in experiments in nuclear fusion, plasma physics, and the generation of X-rays. [*New Sci*, 151 (No. 2045) 1996, 22].

□

RS

Acoustic ice breakers for harbours developed

A Canadian marine engineer, Dr Pen Andersen at the University of Toronto has recently developed a novel acoustic wave generator to control ice formation during wintery in the vicinity of harbours. It has often been a wintery problem in northern coastlines that sudden ice formation can seriously disrupt ship movement and berthing in ports. The new wave generator

can prevent sea water from freezing over by producing artificial waves which somehow annuls the tidal waves in the vicinity berthing systems so as to mix warm water with freezing water periodically; this mixing naturally prevents ice formation. This is not easily feasible in usual machines like bubbler systems and wind-turbines used in ports, as they can handle local vertical columns of water only.

The acoustic ice making machine (7-5m long) consists of a floating helical roller (Fig 1) similar to a large corkscrew, supported at either end by pontoons. The roller is rotated in the water by an electric motor to create a train of waves several hundred millimeters high.

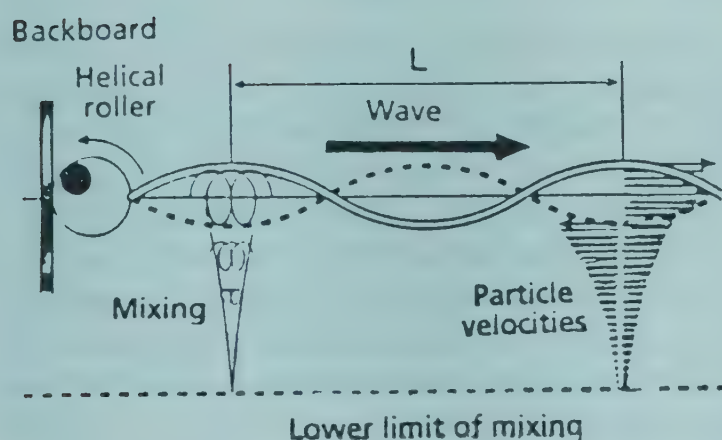


Fig 1- Acoustic wave generator for ice breaking.

According to Dr Andersen, artificial waves have a higher height- to-length ratio than natural waves, making them better able to displace water. As a result more water is drawn up from the warmer depths of the sea. It is said that greater mixing occurs at the surface, just where the de-icing effect needs to be the greatest. The mixing action of artificial waves extends to a depth of half the wavelength (viz 60 cm nearly) for the wave generator projector. With a conventional propeller-driven de-icing system, mixing is less effective because particle velocities tend towards zero near the surface.

Trials of the new system in Oshawa harbour, Ontario, have produced artificial waves nearly 150 millimetres high, exceeding Andersen's theoretical projections by half. The wave train measured over 15 metres in width and 100 metres in length, and would

certainly have had an effect on ice formation and furthermore it takes very little energy to produce the waves.

However at Toronto harbour, a single main access channel makes the ferry berths particularly vulnerable to ice and the Chief engineer with the Toronto Harbour Commissioners, has stated that Andersen's wave generator could be used where a build up of ice in the berths tends to damage the quay. The machine worked well at pushing ice out of the way at Oshawa.

Meanwhile, an environmental group based in Atlanta is building a version of the generator measuring 5 metres long to improve water quality in lakes. They believe that better aeration will reduce problems such as excessive algal bloom, weed growth and eutrophication [*New Sci* **151** (No 2043) 1996, 23]. □

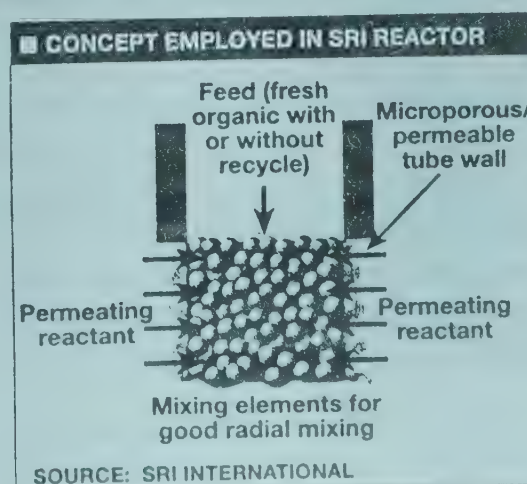
RS

Reactor using porous wall technology developed

Technologists at the SRI, USA, have developed a reactor which is being tested in the laboratory on a difficult exothermic sulphonation process. This new design of reactor, employing porous wall technology to control reaction speed, hints at lower capital and operating costs than a falling film design and reduced pollution.

The reactor can be used in several reactions such as alkylations, halogenations, and polymerisations.

SRI developed the reactor to meet the need for better control of exothermic processes and reduce the problems of hot spots and inhomogenous reactant concentrations. These can result in the production of undesirable by products and excess consumption of raw materials.



SOURCE: SRI INTERNATIONAL

With the help of a computer model, a porous wall reactor was designed through which one of the reactant is added progressively throughout the reactor volume. Heat of reaction can be controlled by limiting the quantity of second reactant introduced and by heat exchangers in recycle or interstage lines. Balls inside the reactor tubes give good redical mixing.

The economics of methyl laurate sulphonation has been studied in a 23,000 tonne/y plant using the latest falling film technology and the SRI process. The falling film equipment comprise 100 tubes of 1.0in internal diam and 15 ft long and a 400 BHP compressor. The porous wall reactor contained 189 tubes of 0.625in internal diam and 39in active length contained in an overall shell size of 45in long and 19in diam.

The new reactor is claimed to be five-times cheaper than a falling film unit. In a retrofit project equipment costs are in the range of \$250,000 while overall capital investment in a grass roots plant is reduced by \$4.3m, or 30%, to \$9.4m for the SRI technology. Total product cost is calculated at 79 cmt pb for SRI's reactor compared with 87 cost pb for the falling film process.

SRI is collaborating with the Center for Waste Reduction Technology of the Americal Institute of Chemical Engineers and Air Products, Eastern Chemical, Monsanto, Olin and Rhone-Poulenc as co-sponsors. Commercialisation of the reactor will be done after presentation of the results from the bench scale trials [*Eur Chem News*, 66 (1732) (1996) p.31].

HKK

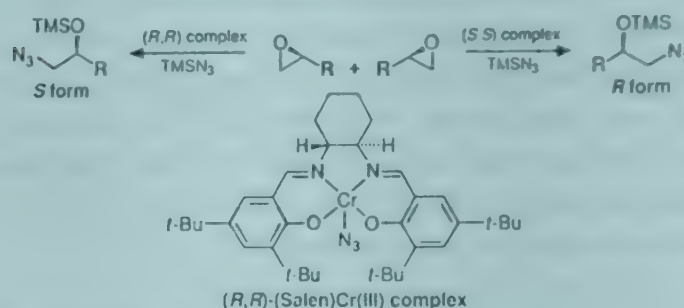
New route to amino alcohols developed

Chemists at the Harvard University, USA, have devised a direct and efficient route to 1,2-amino alcohols from readily available epoxides. The reaction provides an immediately useful alternative to existing methods for making the important synthetic intermediates.

Eric N Jacobsen and his group has developed a reaction, which involves ring-opening of terminal epoxides with trimethylsilyl azide in the presence of a chiral catalyst [*J Am Chem Soc*, 118 (1996) p. 7420]. When a racemic mixture of epoxides reacts in the presence of a single enantiomer of the catalyst, one epoxide enantiomer reacts more rapidly than the other.

The strategy, called kinetic resolution, uses a chemical reaction to separate enantiomers. It is useful

Catalyst controls which epoxide enantiomer reacts



TMS = trimethylsilyl; t-Bu = *tert*-butyl

when the racemic material is inexpensive and the enantiopure product is valuable.

Enantiopure 1,2-amino alcohols are difficult to make. Jacobsen's reaction complements a route from alkenes reported earlier. The reaction's simplicity ensures its rapid adoption (*Chem Eng News*, 19 February 1996, p. 6).

The chiral catalyst is chromium complexed with a tetradentate salen (from salicylide ethylenediaminato) ligand derived from 1,2-diaminocyclohexane and *tert*-butylsalicylaldehyde. Depending on the ligand's configuration, the catalyst delivers the azide group to a particular carbon atom of one of the two enantiomers of the epoxide, generating a 1-azido-2-trimethylsiloxyalkane in high optical purity. Removal of the trimethylsilyl group and reduction of the azide group yields 1,2-amino alcohol.

For example, when ($\pm$)-propylene oxide, an inexpensive material, reacts in the presence of the *R,R* complex, (*S*)-1-azido-2-trimethylsiloxypropane is formed in quantitative yield with 97% enantiomeric excess. Only a negligible amount, less than 1%, of the regioisomeric product is formed.

The catalyst's almost perfect enantioselection, even for tiny propylene oxide, is surprising.

Jacobsen *et al.* demonstrated the strategy by synthesizing the antihypertensive drug (*S*)-propranolol from a racemic epoxide prepared from epichlorohydrin and 1-naphthol. They also prepared a compound with prophylactic activity against infection with simian immunodeficiency virus-(*R*)-9-[2-(phosphonomethoxy)propyl] adenine (PMPA), from ($\pm$)-propylene oxide. The overall yields from the racemic starting materials, 34% for (*S*)-propranolol and 10% for PMPA, are impressive, because in a kinetic resolution, the maximum yield is only 50%.

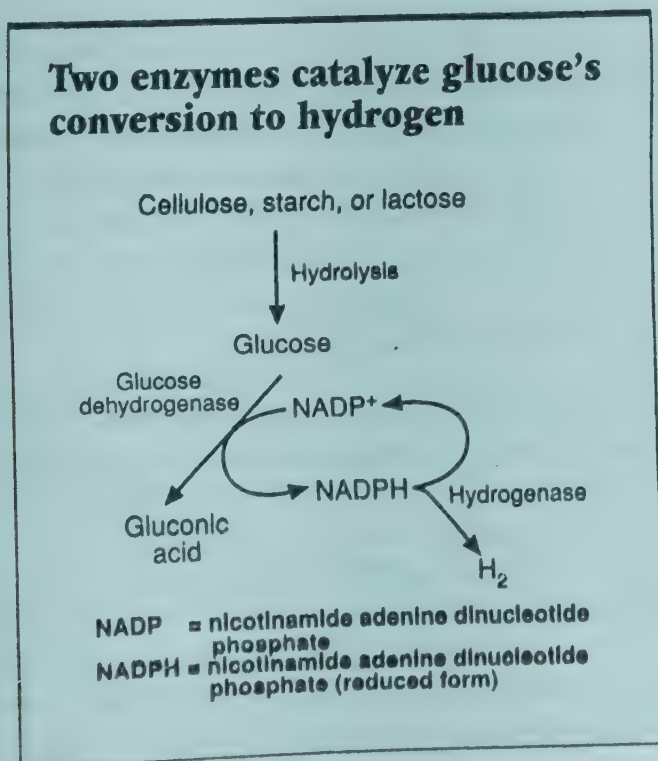
The mechanism of the ring-opening reaction is novel, involving cooperative behaviour that could be the basis of a new way to design catalysts [*Chem Eng News*, 74 (33) (1996) p. 10].

□
HKK

Enzymatic route makes hydrogen from glucose

Jonathan Woodward and his colleagues at the Department of Energy, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tenn, have demonstrated a new enzymatic procedure to make molecular hydrogen. It is a simple system which operates at or near ambient conditions, using renewable resources. Its only product besides hydrogen is gluconic acid, a commodity chemical. The work was done in collaboration with biochemists from the University of Bath, UK, and the University of Georgia, USA [*Nat Biotech*, 14(1996)p.879].

So far, very little attention has been paid to enzymatic conversion of glucose derived from biomass. The ORNL method uses glucose dehydrogenase (GDH) obtained from animal and bacterial sources to oxidize glucose to glucono- δ -lactone, which then hydrolyzes to gluconic acid. The enzymatic cofactor is either NAD^+ (nicotinamide adenine dinucleotide) or NADP^+ (nicotinamide adenine dinucleotide phosphate), which is correspondingly reduced. A second enzyme, a hydrogenase, removes hydrogen from the cofactor, returning it to its oxidized form.



Hydrogenases do not usually interact with physiological electron carriers, but according to Woodward, at least two interest — one from the aerobic bacterium *Alcaligenes eutrophus* and the other from the anaerobic archeon *Pyrococcus furiosus*. Both hydrogenases use NADPH as electron donor, opening the possibility of coupling hydrogenase and GDH to generate molecular hydrogen from glucose.

In principle, the glucose source could be any material containing cellulose, including newsprint, starch, and lactose — all abundant, renewable resources. Cellulose can be converted to glucose with cellulases. It has been shown that when cellulase is added, the system converts cellulose to hydrogen in a single stage. The rate - limiting step being cellulose conversion to glucose.

The process is presently yielding about 8% hydrogen from glucose, which probably would not generate much commercial interest.

However, gluconic acid could be further converted to yield more hydrogen.

In the ORNL experiments, the cellulose was purchased commercially. For commercial operation, it would be produced on-site, substantially cutting its price. A small-scale operation could recover some costs by selling the byproduct gluconic acid, which is used as a sequestering and chelation agent. But a major commercial operation to produce hydrogen from glucose would probably produce more gluconic acid than the market requires, providing another incentive to convert gluconic acid to more hydrogen.

The US cellulosic waste presently totals about 16 billion lb/y. If all were converted to hydrogen, it would yield about 37.5 billion standard cubic feet of the gas, with an available heat content of about 12.2 trillion Btu — the energy equivalent of about 100 million gal of gasoline.

An attempt is now being made to optimize the reaction for pH, temperature, and enzyme ratio. Immobilization of GDH and hydrogenase is also being considered in a biprocess for long-term, continuous hydrogen production [*Chem Eng News*, 74(28) (1996)p.5].

□
HKK

Incubators create small technology companies

According to the study carried out at the National Business Incubation Association, Athens, Ohio, about 27% of business incubator tenants are involved in R&D and technology-based products. Another 36% are service-oriented firms, 20% are involved in light manufacturing, and 17% in other areas. In the burgeoning sector of technology incubators, new businesses often are based on biotechnology, computer science, electronics and advanced materials.

Collaborative Laboratories spent about 3y at the Long Island High Technology Incubator. The firm is a leading producer of liposomes and conducts contract research and manufacturing in biotechnology, pharmaceuticals, cosmetics, and environmental sciences. Although it "graduated", the company still has ties to the incubator and will operate a contract biological manufacturing facility being built there.

DNX came out of the Ohio University Innovation Center after 6y. The new publicly traded company provides drug development services to the pharmaceutical industry. In the first quarter of 1996, it reported its first profit of \$18,000 on revenues of \$7.12 million.

DAIS Corp., presently a Rensselaer Polytechnic Institute Incubator company, is developing polymer-based, low-cost power sources. The materials being used in product development were pioneered at Rensselaer. Another RPI Incubator graduate company is Intermagnetics General, which develops and markets super-conducting magnets and power transmission systems.

Sphinx Pharmaceuticals, the combinatorial chemistry company acquired by Eli Lilly in 1994 for more than \$75 million, received funding from the North Carolina Biotechnology Center (NCBC). Other public companies that have received NCBC grants or loans are the diagnostics company Editek, chemical testing services company EnSys, and animal agriculture firm Embrex [*Chem Eng News*, 76(22)(1996)p.11]. □

HKK

Titanium-containing zeolites as selective oxidation catalysts

In the early 1980s, researchers at the EniChem, Italy, showed that a zeolitic material containing titanium, known as titanasilicate (TS-1), was endowed with new catalytic properties. According to Sir John Meurig

Thomas, of the Royal Institution, UK, TS-1 is a wonderful selective oxidation catalyst capable of converting propylene to propylene oxide and phenol to hydroquinone in the presence of hydrogen peroxide.

It was found by the EniChem researchers that replacing some of the silicons in the framework with titanium conferred remarkable catalytic properties.

Since then, many groups worldwide have been working on the development of titanasilicate materials for use as catalysts.

Thomas and his group has been successful in anchoring titanocene, an organotitanium complex, inside a mesoporous zeolite called MCM-41 (*Chem Eng News*, 13 November 1996, p. 6). Mesoporous zeolites have channel openings of 20 Å° to 100 Å°, whereas those of microporous zeolites are less than 10 Å°. The new material was an effective catalyst for the epoxidation of alkenes.

In related work, Avelino Corma *et al.* of Polytechnic University of Valencia, Spain, have recently reported the synthesis of aluminium-free Ti-β zeolite. They have shown that the material is more active and selective than TS-1 for the epoxidation of alkenes with hydrogen peroxide [*Chem Commun*, (1996) p. 1339].

Zeolite Ti-β has a unique large-pore channel system. It is more active than TS-1 for the epoxidation of cyclic and branched alkanes and alkenes with aqueous hydrogen peroxide and also shows high activity and selectivity when organic hydrogenperoxides are used as oxidizing agents.

However, aluminium in zeolite Ti-β catalysts results in acidsites within the porous framework. According to Corma *et al.*, these sites have a "detrimental effect on the activity and selectivity of the catalyst. Thus, there is a strong incentive for the production of aluminium-free Ti-β catalysts by clean and reproducible direct synthesis methods".

J Kerry Thomas and his coworkers at the University of Notre Dame are studying microporous titanosilicates known as ETS-4 and ETS-10. Unlike TS-1, in which each titanium atom is coordinated to four oxygen atoms, ETS-4 and ETS-10 contain six-coordinate titanium atoms.

These materials work well as normal catalysts and seem to absorb hydrocarbons extremely well. The

main concern of the researchers is with the photochemistry of these materials. It is hoped to get cracking by using light to supply the energy rather than heat. The aim is to crack larger oils to form smaller gasoline-like ones at room temperature.

Thomas and his research associate Xinsheng Liu at the University of Notre Dame have recently reported a "new and more practical" avenue for synthesizing ETS-4 and ETS-10 [*Chem Commun*, (1996) p. 1435]. They have used thermodynamically stable crystalline forms of titanium dioxide as a source of titanium to prepare the materials under hydrothermal conditions. Earlier methods of synthesis reported in the literature use titanium chlorides as the titanium source [*Chem Eng News*, 74 (31) (1996) p. 48].q

HKK

Even chewing the fat is bad for arteries

Richard Mattes and his colleagues at the Purdue University, Indiana, have found that even the mere taste of crisps, cheesecake or croissants is bad for arteries.

Researchers asked volunteers to swallow capsules of unsaturated vegetable oil, then chew fatty food like cream cheese for one minute and spit it out without swallowing any. Within hours, levels of fatty molecules called triglycerides circulating in the volunteers' blood shot up. At the end of four hours the volunteers' blood contained 65% more triglycerides than that of control subjects who had chewed very low fat cream cheese (*Am J Clin Nutr*, June 1996).

Mattes believes the triglyceride surge was triggered by the sensations of taste and odour, which affected the metabolism and uptake into the blood of the vegetable oil consumed by the volunteers. How this happens is yet not known, as the biochemical pathways linking taste buds to fat metabolism are not understood.

It is believed that high triglyceride levels are associated with an increased risk of cardiovascular disease. There may be significant health implications and replacing fatty foods with low-fat substitutes may have benefits that go beyond a simple reduction in fat consumption.

The next step will be to vary the relative amounts of saturated and unsaturated fat in the testing samples and diet before measuring triglyceride levels. It will also be investigated whether tasting fatty food affects the

amount of cholesterol circulating in the blood [*New Sci*, 150 9106)(1996)p.10]

□

HKK

Zinc plays a role in nerve cell death

A group lead by Dennis Choi at the Washington University School of Medicine, US, has used a zinc chelator to investigate the role of zinc in the degeneration of nerve cells (neurones) following an induced condition called transient cerebral ischaemia, which temporarily stops blood supply to the forebrain [*Science*, 272 (1996) p. 1015]. This mimics some of the effects of a stroke or blood clot.

Researchers had earlier investigated ion chelators like EDTA (ethylenediaminetetraacetic acid and hydroxypyridimones in the treatment of various conditions; to reduce the build-up of toxic levels of blood components such as calcium and iron [*Chem Br*, 30 (1994) p. 886; 29 (1990) p. 565].

Chelatable zinc (Zn^{2+}) occurs throughout the mammalian CNS, though its precise role remains unknown. Earlier work has shown excessive exposure to extracellular Zn^{2+} to be toxic to brain cells, and that Zn^{2+} actually moves into vulnerable neurones (in an area called the hippocampal hilus) which begin degenerating after transient forebrain ischaemia. It is suspected that Zn^{2+} may play a role in cell death, and set out to discover whether this Zn^{2+} movement was simply a marker or actually a cause of these neuronal deaths.

Zn^{2+} was found to accumulate in neurones before they began to degenerate after induced transient forebrain ischaemia. This accumulation was specific to neuronal death induced by Zn^{2+} influx, i.e., not a general accompaniment of cell death. By injecting the Zn^{2+} chelator CaEDTA (disodium EDTA saturated with equimolar Ca^{2+}) into the lateral ventricles of the rats' brain before transient forebrain ischaemia, they reduced Zn^{2+} influx into specific neurones. As a result, there was less neurodegeneration 72h after transient forebrain ischaemia.

Although CaEDTA is not specific to Zn^{2+} , it was shown that removing copper and iron, which are also chelatable by CaEDTA, can be excluded as the cause of their observations. It is concluded that the toxic movement of Zn^{2+} across a nerve junction 'synapse' may well be involved in nerve cell degeneration in certain areas of the brain after a stroke. Rapid counter-

measures specifically aimed at reducing toxic Zn^{2+} influx could therefore be a useful strategy for protecting brain neurones in stroke victims [*Chem Br*, 32 (8) (1996) p. 18]. □

HKK

Honours and Awards

DSIR awards for seven firms

Seven companies have bagged this year's national awards instituted by the Department of Scientific and Industrial Research (DSIR) in the Ministry of Science and Technology for outstanding in-house R&D achievement in different areas and sectors of industry.

The winners are: Armour Polymers Limited, Mumbai (chemicals and allied industries), Hetero Drugs Limited, Hyderabad (drugs and pharmaceuticals industries), Lamco Lightning Arrester Manufacturing Company Private Limited, Hyderabad (electrical industries), Patwa Kinarivala Electronics Limited, Vadodara (electronics industries), Titan Industries Limited, Hosur (mechanical engineering industries), Ankur Seeds Private Limited, Nagpur (Agro industries), and Jain Irrigation Systems Limited, Jalgaon (technology absorption).

The national awards, which were instituted in 1987 to provide recognition to the efforts of industry towards innovative research, competitive technology development and commercialisation of R&D results, had so far been won by 81 companies.

The awards, in the form of silver shields and citations, are to be presented during the tenth national conference on in-house R&D in industry scheduled to be held here on December 10 and 11.

The focal theme of the conference organised by DSIR in association with the Federation of Indian Chambers of Commerce and Industry, is to be "technical consultancy-lever for innovation: perspective to 2000 and beyond".

About 600 delegates from industry, national laboratories, universities, IITs, government and private research organisations, consultancy agencies and Government departments will take part. [*Hindu*, 31 October 1996, p.9].

Announcements

□

The Hannover Industrial Fair, Germany

Hannover Industrial Fair will mark from the April 14th to 19th, 97 at Hannover, Germany, the complete advanced spectrum of industrial technology and will help in shaping the global technical progress. Under a single umbrella this celebration will unite an impressive line up of top trade fairs and at the same time will provide a central forum and meeting place with the technological wizards to pave the way for future development for the international business community.

With figure of 6,750 exhibitors from more than 60 countries, above 350,000 visitors from more than 100 countries and a surface area of 257,00 square meters will witness the success of this extravaganza. The past statistics reflects that it is in regular at the focus of business, political and the media attention.

The major display categories for this fair will be

- *The electric automation technology,
- *Power transmission and control, Subcontracting,
- *Industrial materials, Research and technology,
- *Factory equipments and tools,
- *Compressed air technology,
- *Lighting technology
- *Production equipment for electrical engineering and electronics and with a special emphasis on mechanical and plant engineering and electronic.

For further information please contact: the official tour promoters for this at ORBIT, 1127, Midway Premises, A S Marathi Marg Opp Lucas TVS, Prabhadevi, Mumbai 400 025, Tel: (022) 437 9282/83; Fax: 91-22-430 5707 □

WESTEC 1997

North America's largest annual metal working and manufacturing exposition including outsourcing is being held during March 24- 27, 1997 at Los Angeles Convention Centre, Los Angeles, California. The show sponsors are: Society of Manufacturing Engineers, ASM International, The Materials Information Society, American Machine Tool Distributors Association, Association for Manufacturing Technology. For more information, contact SME Customer Service at (800) 733-4763.

Journal of Scientific & Industrial Research

(Incorporating *Research and Industry*)

Instructions to Contributors

The **Journal of Scientific & Industrial Research** (Incorporating *Research and Industry*) is published monthly to serve as an information link between the generators and users of technologies. It is addressed primarily to industrial entrepreneurs, technologists, engineers, technocrats and administrators in industry. Therefore, original research articles of practical interest to industry are invited for publication.

Contributions should have an economic bias, and wherever possible, cost estimates should be provided. They should be tersely written, giving only the significant results.

Besides, reviews on various branches of science and technology, science/industrial policy and management are also accepted.

Subject Coverage

Scientific Industrial Research

- (i) Scientific investigations successful at the pilot-plant and in-plant trials.
- (ii) Technology upgradation.
- (iii) Development of cheaper and indigenous raw materials as replacement for uneconomical materials.
- (iiv) Import substitution.
- (v) Technologies for rural development.
- (vi) Standardization and quality control.
- (vii) Technologies of waste management.
- (viii) Industrial R&D highlights.

Technology Management

- (i) Success/failure stories in technology management.
- (ii) Technology assessment.

(iii) Technology transfer:

(iv) Technology assimilation and adaption in different industries.

(v) Technology funding including venture capital.

(vi) Human Resource Development.

vii) Management.

(viii) Environmental management.

Industrial Development

(i) Policies, programmes and progress.

(ii) Critical profiles of industries—individual and sectoral.

(iii) Technology Forecasting .

(iv) International Collaboration.

(v) Fiscal incentives aimed at industrial development.

Books, monographs and technical bulletins on industrial methods and techniques as well as other data like production and demand statistics are accepted for review.

A critical analysis of papers presented at any Indian as well as international technology seminar/symposium is also welcome.

Questions on the articles published in the journal, answers supplementing any of the published items, views, opinions, or suggestions on the various aspects of technology are welcome for inclusion in the column, 'readers react'.

The editors are keen in projecting the technology bottlenecks/problems faced by the industry for their solution by the scientists in various laboratories. They would welcome to be mediators between the industry and the laboratory.

Preparation of Manuscript

Manuscripts should be presented in electronic form as well as in hard copy. Pages should be numbered consecutively, and the matter should be arranged in the following order: title; name(s) of author(s); department(s) and institution(s); abstract; keywords; introduction; materials and methods; results and discussion; acknowledgement; and references. The abstract, tables and captions (for figures) should be typed on separate pages.

The electronic form of the manuscript should be submitted on a floppy disk of 5¼" (1.2 MB) or 3½" (1.44 MB) to the Editor along with one hardcopy print out and one xerox copy. Text of the manuscript may be entered using word processing softwares such as Word Perfect Version 5.5/6 or MS Word Version 6 (preferably on IBM compatibles) and for illustrations Corel Draw, Harvard Graphics or any compatible format software (BMP, GIF, JPG, PCX, TIF) may be used. Label the floppy disk with the author(s)' name(s), the word processing package, software for illustrations, and the type of computer. In case of discrepancy between the disk and the manuscript, the latter will be taken as the definitive version.

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In citing *references to research papers*, names and initials of the authors should be followed, in order, by the title of the periodical in the abbreviated form (*italics*), the volume number (**bold**), the year within circular brackets and the first page reference, e.g. Liotta R, Rose K & Hippo`E, *J Org Chem*, **46** (1981) 227.

For names of periodicals, the standard abbreviations listed in the *International Serials Catalogue* published by the International Council of Scientific Union's Abstracting Board should be used. If the reference is to an article published without any

authorship in a periodical, the title of the article takes the place of the author in the citation, e.g. Handloom Sector of Textile Industry in India, *J Mater Sci*, 18 (1983) 1443.

If a paper has been accepted for publication, the names and initials of the authors and the journal title should be given followed by the words "in press" within circular brackets, e.g. Chavan R B & Subramanian A, *J Sci Ind Res*, (in press).

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Reference to a thesis should include the name of the author, title of the thesis (italics), university or institution to which it was submitted, and year of submission, e.g. Ghosh G, *Ph D Thesis, Structure of Coal*, Jadavpur University, Calcutta, India, 1984.

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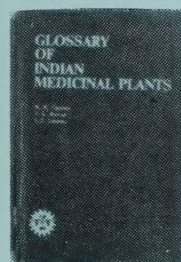
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